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**WO 03/084550 A1**

(54) Title: DRUGS FOR THE ARTHRITIS TREATMENT

(57) Abstract: Anti-inflammatory and/or anti-inflammatory/analgesic compounds having the following general formula (I): A-(B)<sub>u</sub>-(C)<sub>v</sub>-(NO)<sub>x</sub> or salts thereof, wherein: A contains the radical of a non steroidal anti-inflammatory or non steroidal anti-inflammatory/analgesic drug, B and C are bivalent linking groups, are used in the arthritis therapy.

## DRUGS FOR THE ARTHRITIS TREATMENT

\* \* \* \* \*

The present invention relates to the use of drugs for the arthritis therapy.

Arthritis pathological conditions are characterized by a progressive articulation damage due to the cartilaginous matrix degradation. With arthritic diseases, it is generally meant diseases affecting articulations. Specifically rheumatoid arthrites, osteoarthritis, etc. can be mentioned.

The arthritis represents one of the most common medical problems and it is one of the main causes of disability. For example in the United States about 20 millions people result affected by arthritis. The factors which can cause the disease onset are various. Among these articulation traumas, obesity, or diseases modifying the cartilage structure or functionality, such for example rheumatoid arthritis, hemochromatosis, gout or Paget's disease, can be mentioned. Other factors are the age and sex. Generally the disease incidence is higher in women.

The arthritic process pathophysiology is progressive and the symptomatology is gradual and initially starts with the ache onset. The disease evolution determines damages to articulations, to tendons and can compromise leg/arm functionality.

The drugs used at present in the treatment of arthritis are divided into two groups having different modes of action. The drugs of the first group, such as NSAIDs, provide symptomatic relief, but have no influence on the progress of the disease. The drugs belonging to the second group, have different chemical structures from the former and are effective on the course of the disease. For instance they can prevent irreversible joint damage. Said latter drugs are called disease-modifying agents. Presently the use in therapy of disease modifying agents is limited by their toxicity (Martindale, 31st Ed. 1996 pages 11-13).

At present specific therapies which intervene on the disease course reducing the degenerative effects on the cartilaginous matrix, with side effects of small entity, so that the drugs can be used for the long term treatments which are generally required, do not exist.

The existing therapies are directed both to the ache treatment, administering analgesics such for example paracetamol, non steroidal antiinflammatory drugs (NSAIDs), and to the maintenance of the articulation functionality by the intra-articular application of drugs such for example corticosteroids or ialuronic acid, or parenteral such for example perdiacerine, sulfasalazine and penicillamine.

Among the above drugs used to treat the painful symptomatology, paracetamol is known to cause damages to liver and its assumption is contraindicated when other drugs are used. The NSAIDs cause even serious gastric damages and recent studies have shown that they can also accelerate the arthritic disease Rashad S., Lancet 1989, 519-522. The sulfasalazine can cause nausea, head-ache and skin rash. The penicillamine is badly tolerated and gives side effects, for example anorexia, nausea.

It is also known to use particular non steroidal antiinflammatory drugs having a 2-oxo-1H-indolic structure such, for example, Tenidap. This drug differently from the other NSAIDs is effective in arthritis interacting in the cytokine formation, which are endogenous factors responsible for the inflammation and for the degradation of the cartilaginous matrix. However Tenidap causes damages at hepatic and also renal level. See Martindale XXXIth Ed., pages 99-100.

Recently several studies have been directed to explain the arthritis etiopathology. These researches have shown that some inflammatory factors such for example cytokines, chemokines, etc. are involved in the activation of a cascade of catabolic and degenerative events determining the cartilaginous matrix degradation.

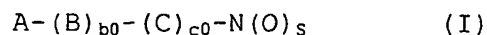
It is known in the prior art that a group of growth factors, TGF- $\beta$  proteins (TGF = transforming growth factor) in

particular TGF- $\beta$ 1, play an important role in the articular cartilage reparation, promoting both the chondrocyte formation and the regeneration process of the bony tissue (osteoclastogenesis) (N. Felisaz et Al. Osteoarthritis and Cartilage (1999) 7 255 267).

The need was felt to have available compounds capable to induce the expression of the TGF- $\beta$  proteins, so to be used in the arthritis treatment, without showing the side effects of the prior art drugs.

The Applicant has surprisingly and unexpectedly found compounds capable to solve the above technical problem.

An object of the invention is the use for the arthritis therapy as disease-modifying drugs of compounds or salts thereof having general formula:



wherein:

$s$  is an integer and is equal to 1 or 2, preferably 2;

$c0$  is an integer and is 0 or 1;

$b0$  is an integer and is 0 or 1; with the proviso that at least one between  $c0$  and  $b0$  is different from zero;

$A = R-T_1-$ , wherein

$R-$  is the radical of a non steroidal antiinflammatory precursor drug excluding the compounds having 2-oxo-1H-indolic structure, or the radical of a non steroidal antiinflammatory/analgesic drug;

$T_1 = (CO)_t$  or  $(X)_{t'}$ , wherein  $X = -O-$ ,  $-S-$ ,  $-N(R_{1c})-$ ,  $R_{1c}$  is H or a  $C_1-C_3$  linear or branched alkyl,  $t$  and  $t'$  are integers and equal to zero or 1, with the proviso that  $t = 1$  when  $t' = 0$ ;  $t = 0$  when  $t' = 1$ ;

$B = -T_B-X_2-T_{BI}-$  wherein

$T_B$  and  $T_{BI}$  are equal or different;

$T_B = (CO)$  when the reactive function in the precursor drug is  $-OH$  or  $-NH(R_{1c})$ ;  $T_B = X$ , as above, when the reactive function in the precursor drug is  $-COOH$ ;

$T_{BI} = (CO)_{tx}$  or  $(X)_{txx}$ , wherein  $tx$  and  $txx$  have the value of 0 or 1; with the proviso that  $tx = 1$  when  $txx = 0$ ,  $tx = 0$  when  $txx = 1$ ;  $X$  is as above;

$X_2$  is a bivalent linking group as defined below;

$C$  is the bivalent radical  $-T_c-Y-$  wherein

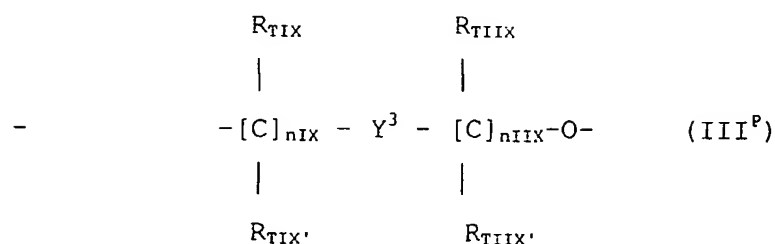
when  $b_0 = c_0 = 1$ :  $T_c = (CO)$  when  $tx = 0$ ,  $T_c = X$  when  $txx = 0$ ,  $X$  being as above;

when  $b_0 = 0$ :  $T_c = (CO)$  when  $t = 0$ ,  $T_c = X$  when  $t' = 0$ ,  $X$  being as above;

when  $c_0 = 0$ :  $tx = 0$ ,  $T_{BI} = X = -O-$ .

$Y$  is:

$Y_p$ :



wherein:

$n_{IX}$  is an integer from 0 to 10, preferably from 1 to 3;

$n_{IIX}$  is an integer from 1 to 10, preferably from 1 to 3;

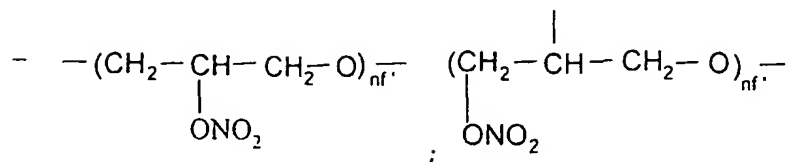
$R_{TIX}$ ,  $R_{TIX'}$ ,  $R_{TIIX}$ ,  $R_{TIIX'}$ , equal to or different from each other are H or  $C_1$ - $C_4$  linear or branched alkyl; preferably  $R_{TIX}$ ,  $R_{TIX'}$ ,  $R_{TIIX}$ ,  $R_{TIIX'}$  are H.

$Y^3$  is an heterocyclic saturated, unsaturated or aromatic ring, having 5 or 6 atoms, containing one or two nitrogen atoms, or  $Y$  can be:

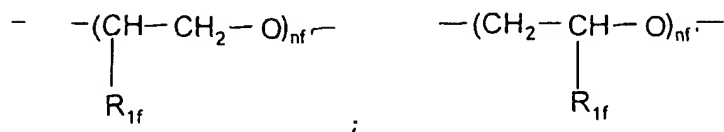
$Y_0$ , selected from the following:

- a  $-R'O-$  alkyleneoxy group wherein  $R'$  is  $C_1$ - $C_{20}$  linear or branched when possible, preferably having from 2 to 6 carbon atoms or a cycloalkylene having from 5 to 7 carbon atoms, in the cycloalkylene ring one or more carbon atoms can be substituted by heteroatoms,

the ring can have side chains of R' type, R' being as above; or one of the following groups:

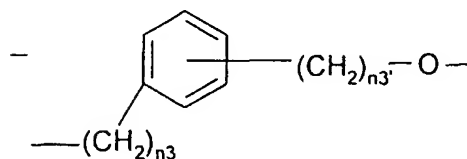


wherein  $\text{nf}'$  is an integer from 1 to 6 preferably from 1 to 4;

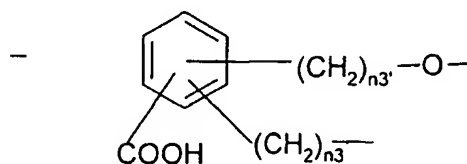


wherein  $\text{R}_{1f} = \text{H}, \text{CH}_3$  and  $\text{nf}'$  is an integer from 1 to 6; preferably from 1 to 4;

or Y is  $\text{Y}_{\text{Ar}}$  and is selected from the following:



wherein  $\text{n}3$  is an integer from 0 to 3 and  $\text{n}3'$  is an integer from 1 to 3;



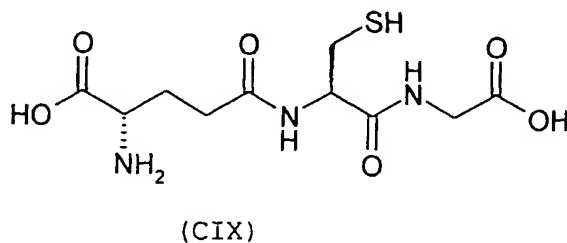
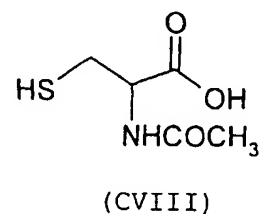
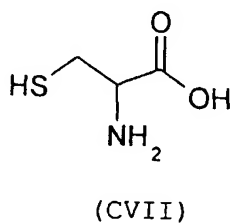
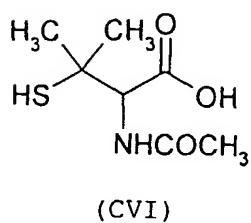
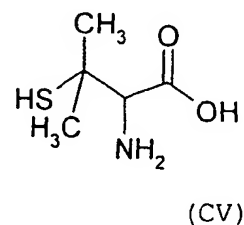
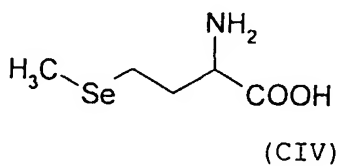
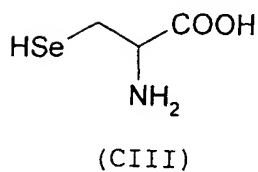
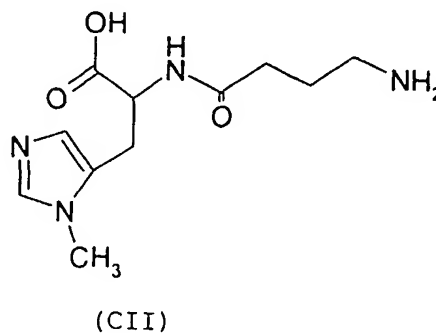
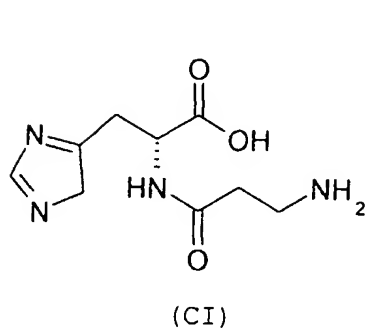
wherein  $\text{n}3$  and  $\text{n}3'$  have the above meaning;

$\text{X}_2$ , bivalent radical, is such that the corresponding precursor of B,  $-\text{T}_\text{B}-\text{X}_2-\text{T}_{\text{BI}}-$  wherein the free valences of  $\text{T}_\text{B}$  and of  $\text{T}_{\text{BI}}$  are each saturated with  $\text{OZ}$ , with Z or with  $-\text{N}(\text{Z}^{\text{I}})(\text{Z}^{\text{II}})$ , wherein  $\text{Z} = \text{H}, \text{C}_1-\text{C}_{10}$ , preferably  $\text{C}_1-\text{C}_5$  linear or branched when possible alkyl,  $\text{Z}^{\text{I}}, \text{Z}^{\text{II}}$  equal or different have the Z values as above, depending on that  $\text{T}_\text{B}$

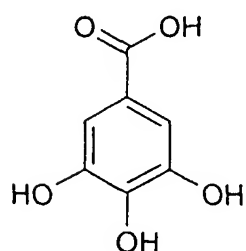
and/or  $T_{Br} = CO$  or  $X$ , in function of the values of  $t$ ,  $t'$ ,  $tx$  and  $txx$ ;

the precursor of  $B$  is selected from the following:

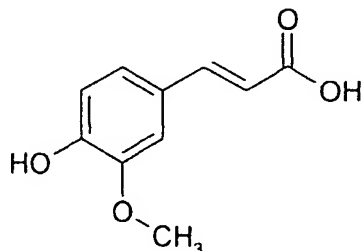
- aminoacids, preferably selected from the following: L-carnosine (formula CI), anserine (CII), selenocysteine (CIII), selenomethionine (CIV), penicillamine (CV), N-acetylpenicillamine (CVI), cysteine (CVII), N-acetylcysteine (CVIII), glutathione (CIX) or esters thereof, preferably ethyl or isopropyl ester:



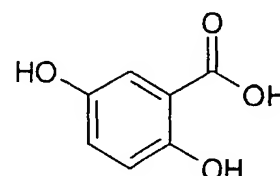
- hydroxyacids, preferably selected from the following: gallic acid (formula DI), ferulic acid (DII), gentisic acid (DIII), citric acid (DIV), caffeic acid (DV), dihydrocaffeic acid (DVI), p-cumaric acid (DVII), vanillic acid (DVIII):



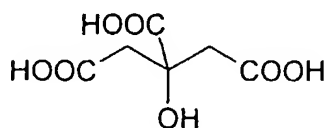
(DI)



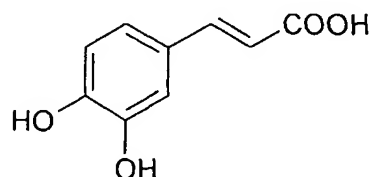
(DII)



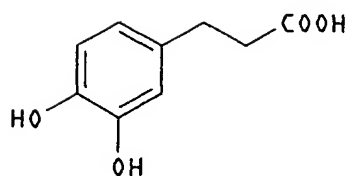
(DIII)



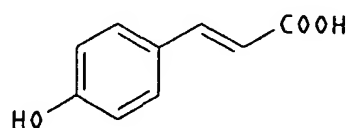
(DIV)



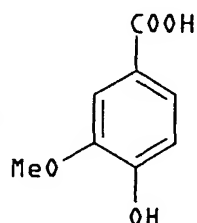
(DV)



(DVI)



(DVII)

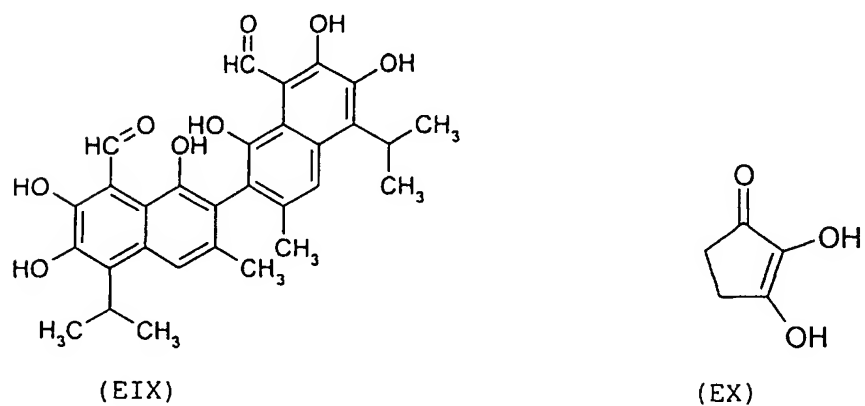
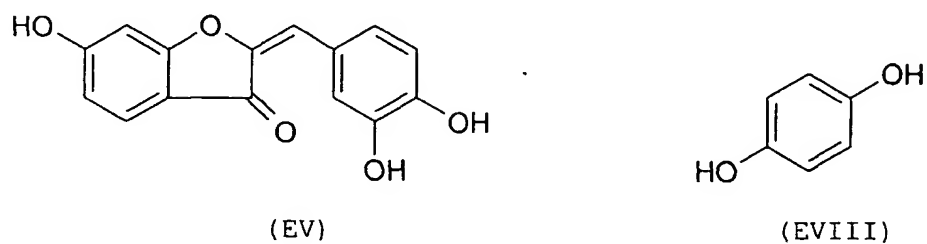
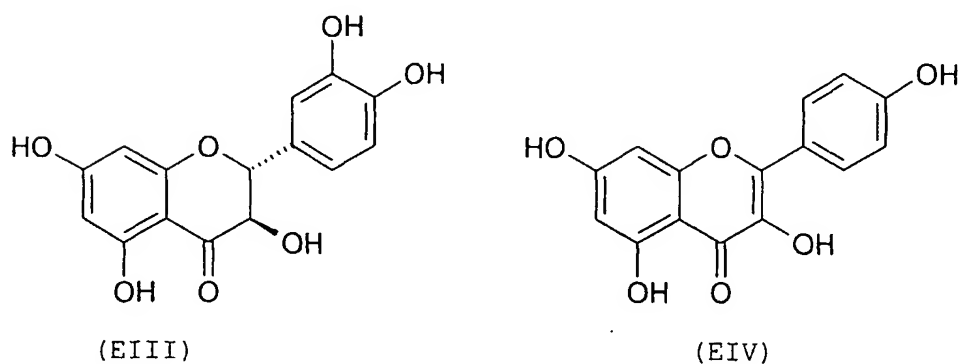
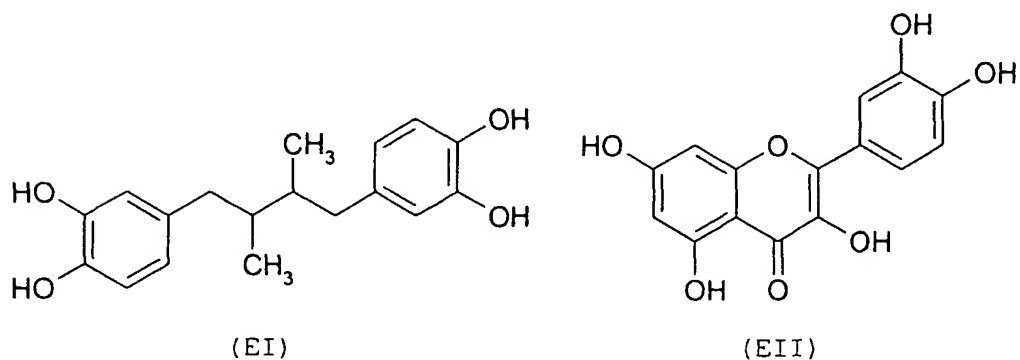


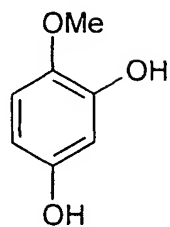
(DVIII)

- aromatic and heterocyclic mono- and polyalcohols, preferably selected from the following: nordihydroguaiaretic acid (EI), quercetin (EII), catekin (EIII), kaempferol (EIV), sulphurethyne (EV), hydroquinone (EVIII), gossypol (EIX), reductic acid (EX), methoxyhydroquinone (EXI), hydroxyhydroquinone (EXII), propyl gallate (EXIII), 3,5-di-ter-butyl-4-hydroxybenzyl-thioglycolate (EXXIV), allopurinol (EXXI); saccharose (EC), ascorbic (ECI) and iso-

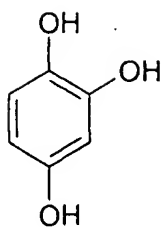


scorbic acid (ECII), p-cumaric alcohol (ECIII), 4-hydroxy-phenylethylalcohol (ECIV), coniferyl alcohol (ECV):

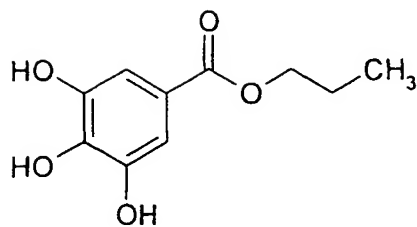




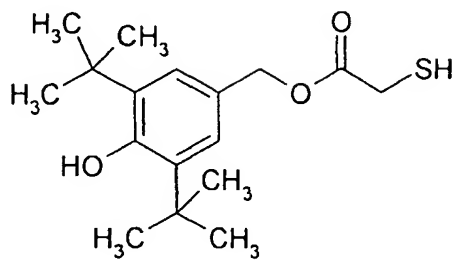
(EXI)



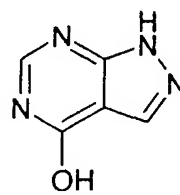
(EXII)



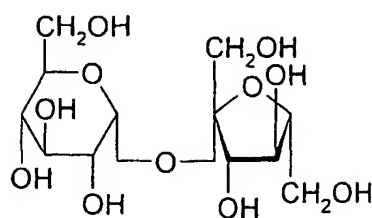
(EXIII)



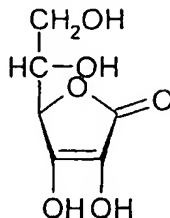
(EXXIV)



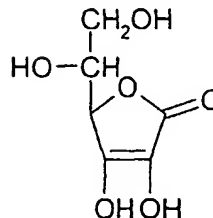
(EXXXI)



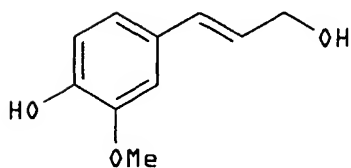
(EC)



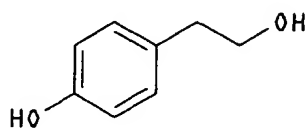
(ECI)



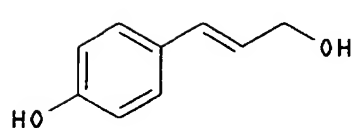
(ECII)



(ECIII)

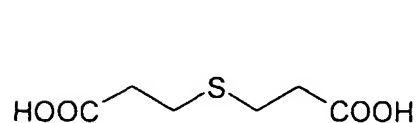


(ECIV)

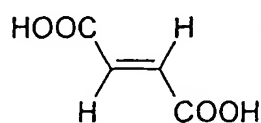


(ECV)

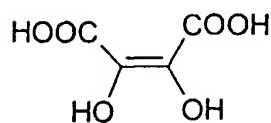
- compounds containing at least one free acid function, preferably selected from the following: 3,3'-thiodipropionic acid (NI), fumaric acid (NII), dihydroxymaleic acid (NIII), edetic acid (NV):



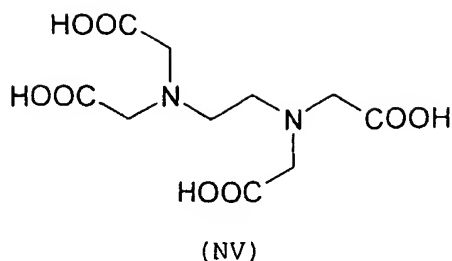
(NI)



(NII)



(NIII)



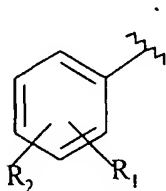
The compounds whose formulas have been indicated above are prepared according to known methods of the prior art, for example described in "The Merck Index", 12a Ed. (1996), herein incorporated by reference. When available, the corresponding isomers and optical isomers can be used.

When  $b_0 = c_0 = 1$  the bonds between the drug radical and  $X_2$  and between  $X_2$  and  $Y$  can be, independently the one from the other, of ester, thioester, amide type; when  $b_0 = 0$  and  $c_0 = 1$  the bond between the drug radical and  $Y$  is of ester, thioester, amide type.

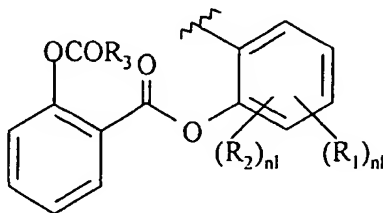
The radical  $R$  of non steroidal antiinflammatory drugs or antiinflammatory analgesic as above defined is selected from the following groups:

Group I)

Ia)



Ib)



wherein:

$R_1$  is H or  $-OCOR_3$ ; wherein  $R_3$  is methyl, ethyl or  $C_3$ - $C_5$  linear or branched alkyl, or the residue of an heterocycle with only

one ring having 5 or 6 atoms which can be aromatic, partially or totally hydrogenated, containing one or more heteroatoms independently selected from O, N and S;

R<sub>2</sub> is hydrogen, hydroxy, halogen, C<sub>1</sub>-C<sub>4</sub> linear or branched when possible alkyl, C<sub>1</sub>-C<sub>4</sub> linear or branched when possible alkoxy; a C<sub>1</sub>-C<sub>4</sub> linear or branched when possible perfluoroalkyl, for example trifluoromethyl; nitro, amino, mono- or di-(C<sub>1-4</sub>) alkylamino;

with the proviso that in formula Ia) R<sub>1</sub> and R<sub>2</sub> cannot be contemporaneously H, preferably when R<sub>1</sub> = H R<sub>2</sub> = OH;

preferably in the compounds of formula Ia) T<sub>1</sub> = -CO- and:

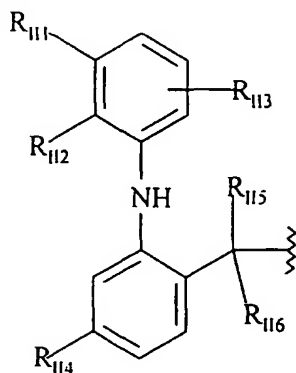
- R<sub>1</sub> = acetoxy, preferably in ortho position with respect to -CO-, R<sub>2</sub> is hydrogen; in this case the formula Ia) represents the acetylsalicylic acid residue;
- R<sub>1</sub> = H R<sub>2</sub> = OH, preferably in ortho position with respect to -CO-, in this case the formula Ia) represents the salicylic acid residue;

in formula Ib) nI is an integer 0 or 1;

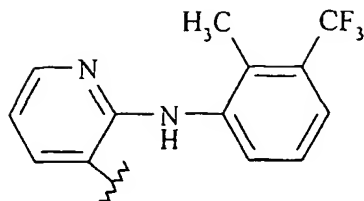
preferably in the compounds of formula Ib) R<sub>3</sub> = CH<sub>3</sub>, nI = 0, T<sub>1</sub> = -CO-; in this case Ib) is the acetylsalicylsalicylic acid residue;

Group II)

IIa)



IIb)



wherein:

R<sub>II5</sub> is H, C<sub>1</sub>-C<sub>3</sub> linear or branched when possible alkyl;

R<sub>II6</sub> has the same meaning of R<sub>II5</sub>, or when R<sub>II5</sub> is H it can be benzyl;

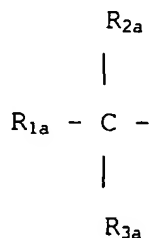
R<sub>III1</sub>, R<sub>III2</sub> and R<sub>III3</sub> can independently be hydrogen, C<sub>1</sub>-C<sub>6</sub> linear or branched when possible alkyl, or C<sub>1</sub>-C<sub>6</sub> linear or branched when possible alkoxy, or Cl, F, Br;

R<sub>III4</sub> is R<sub>III1</sub> or bromine;

the compounds wherein R<sub>III1</sub>, R<sub>III4</sub> are hydrogen and R<sub>III2</sub> and R<sub>III3</sub> are chlorine in ortho position with respect to NH are preferred; R<sub>II5</sub> and R<sub>II6</sub> are H, T<sub>1</sub> = -CO-, when the free valence is saturated with OH the precursor compound is known as diclofenac.

IIb) is the residue of the 2-[(2-methyl-3-(trifluoromethyl)phenyl)amino]-3-pyridinecarboxylic acid when T<sub>1</sub> = -CO- and the free valence is saturated with OH the compound is known as flunixin;

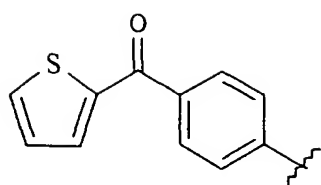
Group III) wherein R is:



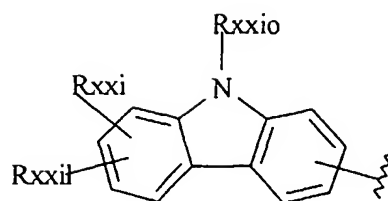
wherein:

R<sub>2a</sub> and R<sub>3a</sub> are H, C<sub>1</sub>-C<sub>12</sub> linear or branched when possible alkyl or allyl, substituted or not, with the proviso that when one of the two is allyl, the other is H; preferably R<sub>2a</sub> and R<sub>3a</sub>, equal or different, are H, C<sub>1</sub>-C<sub>4</sub> alkyl;

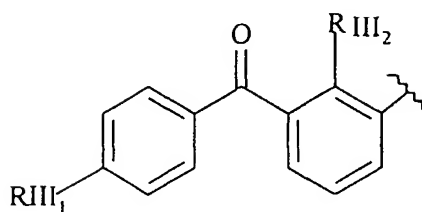
R<sub>1a</sub> is selected from:



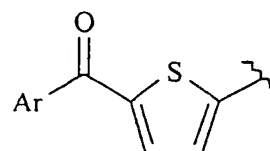
(II)



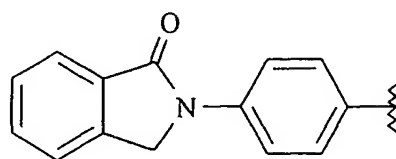
(XXI)



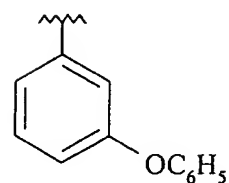
(IV)



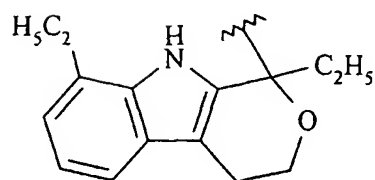
(XXXV)



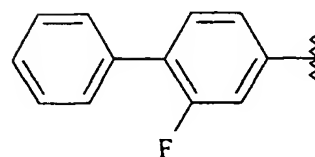
(VI)



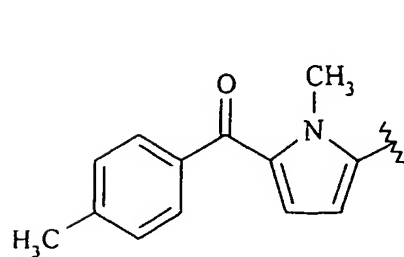
(VII)



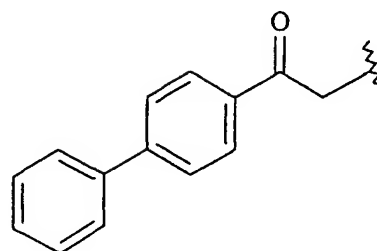
(VIII)



(IX)

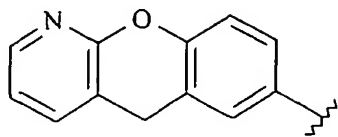


(X)

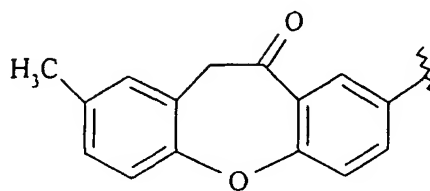


(III)

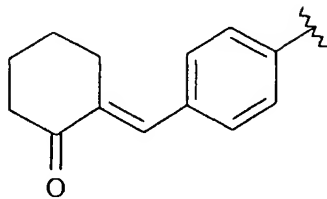
IIID) R<sub>1a</sub> corresponds to the following formulas:



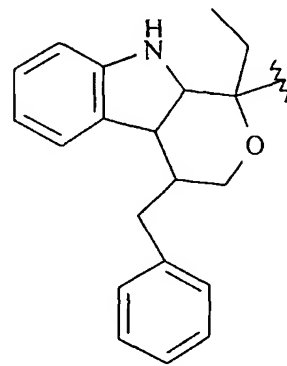
(IIIa)



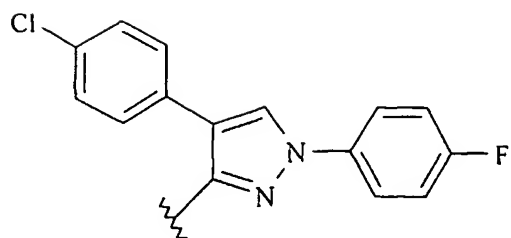
(XXX)



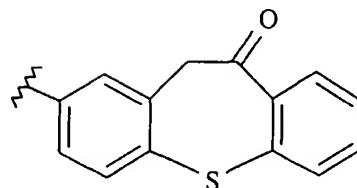
(XXXI)



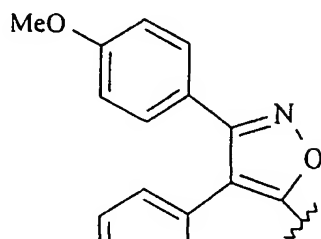
(XXXII)



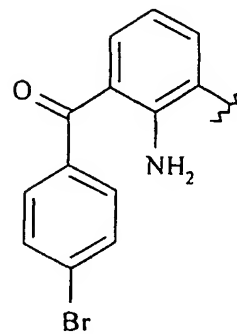
(XXXIII)



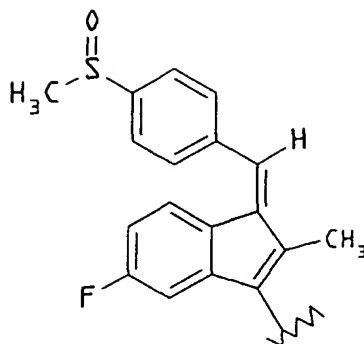
(XXXVI)



(XXXVII)



(XII)



(XXXX)

wherein the meanings are the following:

- when  $R_{1a}$  is as defined in formula (IV), Ketoprofen residue:

$R_{III1}$  is H,  $SR_{III3}$  wherein  $R_{III3}$  is  $C_1$ - $C_4$  linear or branched when possible alkyl;

$R_{III2}$  is H, hydroxy;

the compounds are preferred wherein  $R_{III1}$  and  $R_{III2}$  are H,  $R_{3a}$  is H, and  $R_{2a}$  is methyl,  $T_1 = -CO-$ ;

- when  $R_{1a}$  is as defined in formula (XXI), carprofen residue:

$R_{xxio}$  is H, alkyl from 1 to 6 carbon atoms, linear or branched when possible,  $C_1$ - $C_6$  alkoxy carbonyl linked to a  $C_1$ - $C_6$  alkyl,  $C_1$ - $C_6$  carboxyalkyl,  $C_1$ - $C_6$  alkanoyl optionally substituted with halogens, benzyl or halobenzyl, benzoyl or halobenzoyl;

$R_{xxi}$  is H, halogen, hydroxy, CN,  $C_1$ - $C_6$  alkyl optionally containing OH groups,  $C_1$ - $C_6$  alkoxy, acetyl, benzyloxy,  $SR_{xxi2}$  wherein  $R_{xxi2}$  is  $C_1$ - $C_6$  alkyl;  $C_1$ - $C_3$  perfluoroalkyl;  $C_1$ - $C_6$  carboxyalkyl optionally containing OH groups,  $NO_2$ , amino; sulphonyl, di-alkyl sulphonyl with  $C_1$ - $C_6$  alkyl or difluoroalkylsulphonyl with  $C_1$ - $C_3$  alkyl;

$R_{xxi1}$  is halogen, CN,  $C_1$ - $C_6$  alkyl containing one or more OH groups,  $C_1$ - $C_6$  alkoxy, acetyl, acetamido, benzyloxy,  $SR_{III3}$  being  $R_{III3}$  as above,  $C_1$ - $C_3$  perfluoroalkyl, hydroxy,  $C_1$ - $C_6$  carboxyalkyl,  $NO_2$ , amino,  $C_1$ - $C_6$  mono- or di-alkyl-amino; sulphonyl,  $C_1$ - $C_6$  di-alkyl sulphonyl, or difluoroalkylsulphonyl as above; or  $R_{xxi}$  together with  $R_{xxi1}$  is a  $C_1$ - $C_6$  alkylene dioxy;



the compounds are preferred wherein  $R_{xxio}$  is H, the linking group is in position 2,  $R_{xxi}$  is H,  $R_{xxil}$  is chlorine and is in para position with respect to nitrogen;

$R_{3a}$  is H,  $R_{2a}$  is methyl and  $T_1 = -CO-$ ;

- when  $R_{1a}$  is as defined in the formula (XXXV) tiaprofenic acid residue:

Ar is phenyl, hydroxyphenyl optionally mono or polysubstituted with halogen, alkanoyl and  $C_1-C_6$  alkoxy,  $C_1-C_6$  preferably  $C_1-C_3$ , trialkyl, cyclopentyl, cyclohexyl, cycloheptyl, heteroaryl, preferably thienyl, furyl optionally containing OH, pyridyl;

the preferred compounds of (XXXV) are those wherein Ar is phenyl,  $R_{3a}$  is H,  $R_{2a}$  is methyl and  $T_1 = -CO-$ ;

- when  $R_{1a}$  is as defined in formula (II), suprofen residue, of which that preferred has been indicated, in which  $R_{3a}$  is H,  $R_{2a}$  is methyl and  $T_1 = -CO-$ , as described and obtained in USP 4,035,376 herein incorporated by reference;
- when  $R_{1a}$  is as defined in formula (VI), R is the residue of indoprofen when  $T_1 = -CO-$ ,  $R_{2a} = H$  and  $R_{3a} = CH_3$ ; of indobufen when  $R_{2a}$  is H and  $R_{3a} = C_2H_5$ ;  $T_1 = -CO-$ , as described and obtained according to USP 3,997,669 herein incorporated by reference;
- when  $R_{1a}$  is as defined in formula (VIII), R is the etodolac residue when  $R_{2a} = R_{3a} = H$  and  $T_1 = -CO-$ , as described and obtained according to USP 3,843,681 herein incorporated by reference;
- when  $R_{1a}$  is as defined in formula (VII), R is the fenoprofen residue when  $R_{3a} = H$ ,  $R_{2a} = CH_3$  and  $T_1 = -CO-$ , as described and obtained according to USP 3,600,437 herein incorporated by reference;
- when  $R_{1a}$  is as defined in formula (III), R is the fenbufen residue when  $R_{2a} = R_{3a} = H$  and  $T_1 = -CO-$ , as described and obtained according to USP 3,784,701 herein incorporated by reference;
- when  $R_{1a}$  is as defined in formula (IX), R is the flurbiprofen residue when  $R_{3a} = H$ ,  $R_{2a} = CH_3$ ,  $T_1 = -CO-$ ;

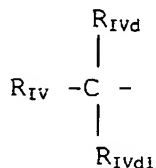
- when  $R_{1a}$  is as defined in formula (X) R is the tolmetin residue when  $R_{2a} = R_{3a} = H$ ,  $T_1 = -CO-$ , as described and obtained according to patent FR 1,574,570 herein incorporated by reference;

In Group IIID)  $R_{1a}$  corresponds to the following formulas:

- IIIa), when  $R_{2a} = H$  and  $R_{3a} = CH_3$  the pranoprofen residue is obtained:  $\alpha$ -methyl-5H-[1]benzopyran-[2,3-b]pyridin-7-acetic acid; in the preferred compound  $R_{2a} = H$ ,  $R_{3a} = CH_3$ ,  $T_1 = -CO-$  and in the precursor the free valence is saturated with OH;
- (XXX), when  $R_{2a} = H$  and  $R_{3a} = CH_3$  the bermoprofen residue is obtained: dibenz[b,f]oxepin-2-acetic acid; in the preferred compound  $R_{2a} = H$ ,  $R_{3a} = CH_3$ ,  $T_1 = -CO-$ ;
- (XXXI), when  $R_{2a} = H$  and  $R_{3a} = CH_3$ , R is the radical of the compound CS-670: 2-[4-(2-oxo-1-cyclohexyliden methyl) phenyl]propionic acid; the preferred compound has  $R_{2a} = H$ ,  $R_{3a} = CH_3$ ,  $T_1 = -CO-$ ;
- (XXXII), when  $R_{2a} = R_{3a} = H$ , the pemedolac residue is obtained; when  $R_{2a} = R_{3a} = H$   $T_1 = -CO-$ ;
- (XXXIII), when  $R_{2a} = R_{3a} = H$ , the pirazolac residue is obtained: 4-(4-chlorophenyl)-1-(4-fluorophenyl)-3-pyrazole acid derivatives;  
the preferred compounds have  $R_{2a} = R_{3a} = H$ ,  $T_1 = -CO-$ ;
- (XXXVI), when  $R_{2a} = H$ ,  $R_{3a} = CH_3$  the zaltoprofen residue is obtained; when the residue is saturated with a hydroxyl or aminic group, or with the carboxylic function, the compounds are known as dibenzothiepine derivatives; in the preferred compounds  $R_{2a} = H$ ,  $R_{3a} = CH_3$ ,  $T_1 = -CO-$ ;
- (XXXVII), when  $R_{2a} = R_{3a} = H$  the mofezolac residue is obtained: 3,4-di(p-methoxyphenyl)isoxazol-5-acetic acid when the residue is  $CH_2-COOH$ ; in the preferred compounds  $R_{2a} = R_{3a} = H$ ,  $T_1 = -CO-$ ;
- (XII), when  $R_{2a} = R_{3a} = H$  the bromfenac residue is obtained: 2-amino-3-(4-bromobenzoyl)benzeneacetic acid; the preferred compounds have  $T_1 = -CO-$ ,  $R_{2a} = R_{3a} = H$ ;

- (XXXX) when  $R_{2a} = R_{3a} = H$  the sulindac residue is obtained: (Z)-5-fluoro-2-methyl-1-[[4-(methylsulphonyl)-phenyl]-methylene]-1H-inden-3-acetic acid; the preferred compounds have  $T_1 = -CO-$ ,  $R_{2a} = R_{3a} = H$ ;

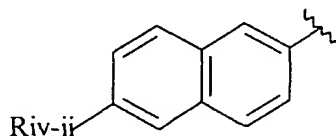
in group IV) R is



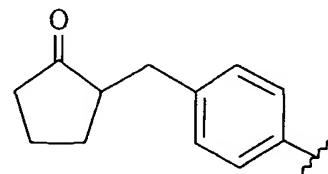
wherein:

$R_{IVd}$  and  $R_{IVd1}$  are at least one H and the other an alkyl from  $C_1$  to  $C_6$  linear or branched when possible, preferably  $C_1$ - $C_2$ , or difluoroalkyl with  $C_1$ - $C_6$  alkyl,  $C_1$  preferred, or  $R_{IVd}$  and  $R_{IVd1}$  form together a methylene group;

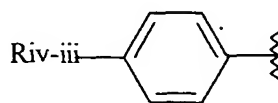
$R_{IV}$  has the following meaning:



(IIB)



(XB)

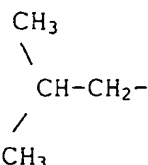


(IIIB)

wherein the compounds of group IV) have the following meaning:

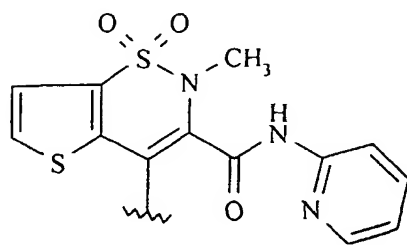
- in formula (IIB)
- $R_{IV-ii}$  is  $C_1$ - $C_6$  alkyl,  $C_3$ - $C_7$  cycloalkyl,  $C_1$ - $C_7$  alkoxyethyl,  $C_1$ - $C_3$  trifluoroalkyl, vinyl, ethynyl, halogen,  $C_1$ - $C_6$  alkoxy, difluoroalkoxy with  $C_1$ - $C_7$  alkyl,  $C_1$ - $C_7$  alkoxyethyl, alkylthiomethoxy with  $C_1$ - $C_7$  alkyl, alkyl methylthio with  $C_1$ - $C_7$  alkyl, cyano, difluoromethylthio, phenyl- or phenylalkyl substituted with  $C_1$ - $C_8$  alkyl; preferably  $R_{IV-ii}$  is  $CH_3O-$ ,  $R_{IVd}$  is H and  $R_{IVd1}$  is  $CH_3$ , and is known as naproxene residue;  $T_1 = -CO-$ ;

- in formula (XB), of which the loxoprofen residue has been indicated, described in USP 4,161,538 herein incorporated by reference, the compounds are preferred wherein  $R_{IVd}$  is H and  $R_{IVd1}$  is  $CH_3$ ;  $T_1 = -CO-$ ;
- in formula (IIIB):  
 $R_{IV-iii}$  is a  $C_2-C_5$  alkyl, optionally branched when possible,  $C_2$  and  $C_3$  alkyloxy, allyloxy, phenoxy, phenylthio, cycloalkyl from 5 to 7 C atoms, optionally substituted in position 1 by a  $C_1-C_2$  alkyl;  
 it is preferred the compound wherein  $R_{IV-iii}$  is

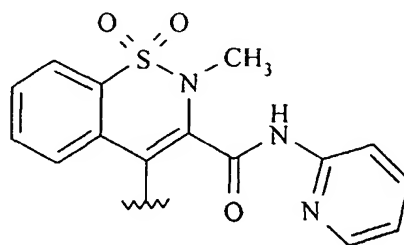


and  $R_{IVd} = H$ ,  $R_{IVd1}$  is  $CH_3$ , compound known as ibuprofen residue,  $T_1 = -CO-$ ;

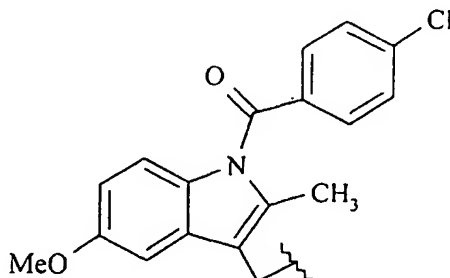
Group V)



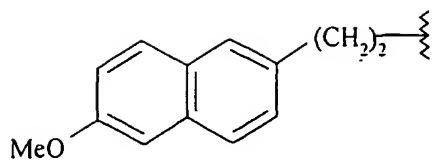
(VIIC)



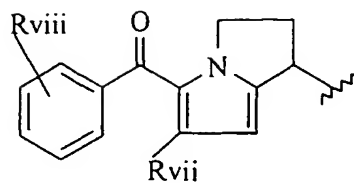
(IXC)



(IVC)

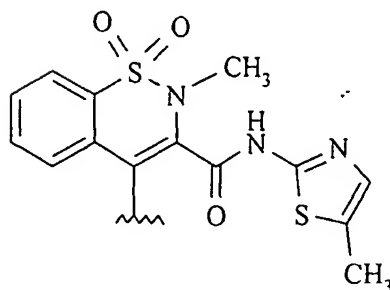


(IIIIC)

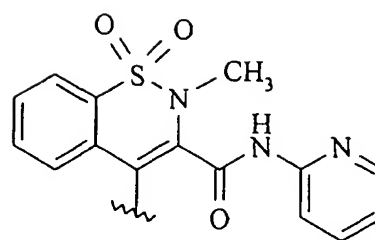


(IIC)

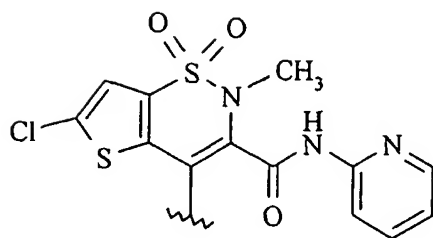
Group VE)



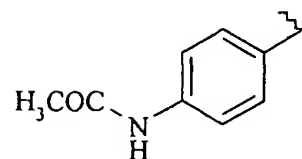
(XC)



(XI)



(XIII)



(XXXXV)

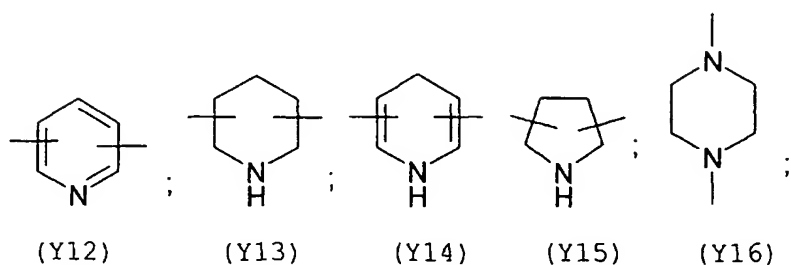
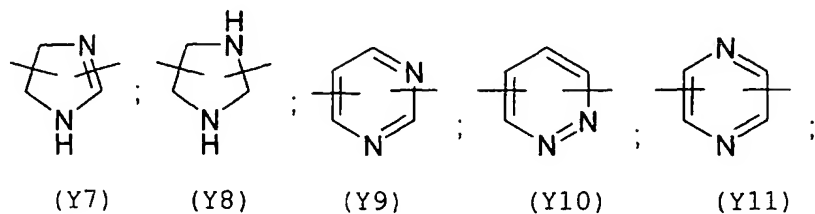
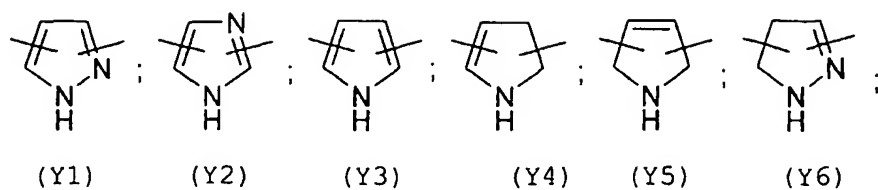
In group V), the compounds have the following meanings:

- when R is the formula (IIC),  
 $R_{vii}$  is H or a  $C_1$ - $C_4$  linear or branched when possible alkyl;  
 $R_{vii-1}$  is  $R_{vii}$ , or  $C_1$ - $C_4$  linear or branched when possible alkoxy; Cl, F, Br; the position of  $R_{vii-1}$  being ortho, or meta, or para;

- the Ketorolac residue is preferred, wherein  $R_{VII}$  and  $R_{VII-1}$  are H, and  $T_1 = -CO-$ ;
- when R is the formula (VIIC),  
of which the tenoxicam residue has been indicated,  $T_1 = -O-$ , as described and obtained in patent DE 2,537,070 herein incorporated by reference;
  - when R is the formula (IXC),  
wherein  $T_1 = -O-$ , the piroxicam residue has been indicated, as described and obtained in USP 3,591,584 herein incorporated by reference;
  - when R is the formula (IIIC)  
wherein  $T_1 = -CO-$ , of which the nabumetone residue has been indicated, as described and obtained in USP 4,061,779 herein incorporated by reference;
  - when R is the formula (IVC)  
wherein  $T_1 = -CO-$ , of which the indomethacin residue has been indicated, as described and obtained in USP 3,161,654 herein incorporated by reference;
  - when R is the formula (XC), the residue X is known as meloxicam; the preferred compounds are those wherein  $T_1 = -CO-$ ;
  - when R is the formula (XI) the residue is known as ampiroxicam when the termination is  $-CH(CH_3)OCOC_2H_5$ ; the preferred compounds have  $T_1 = -CO-$ ;
  - when R is the formula (XIII) and the valence is saturated with H, the residue derives from lornoxicam; the preferred compounds have  $T_1 = -O-$ ;
  - when R is the formula (XXXXV),  $T_1 = -O-$  and the valence is saturated with H, the compound known as paracetamol is obtained, as described and obtained in USP 2,998,450 herein incorporated by reference.

The compounds of formula (I) can be obtained as described in WO 95/30641, WO 00/61537, WO 01/12584.

Preferably  $Y^3$  is selected from the following bivalent radicals:



Preferred of  $Y^3$  are the following: (Y12), having the two free valences in the ortho positions with respect to the nitrogen atom; (Y16) with the two valences linked to the two heteroatoms; Y1 (pyrazol) 3,5-disubstituted; Y16 is particularly preferred.

The compounds according to the present invention, when at least one functional group salifiable with acids, for example an aminic group, is present, can be transformed into the corresponding salts. For example one way to form the salts is the following: when one basic nitrogen atom is present in the molecule, it is reacted in an organic solvent such for example acetonitrile, tetrahydrofuran with an equimolecular amount of the corresponding organic or inorganic acid.

Examples of organic acids are: oxalic, tartaric, maleic, succinic, citric, trifluoroacetic acids.

Examples of inorganic acids are: nitric, hydrochloric, sulphuric, phosphoric acids.

When the precursor compounds usable in the present invention have one or more chiral centres, they can be in racemic form or as diastereoisomer mixtures, as single enantiomers or single diastereoisomers; if they show a geometric asymmetry the compounds can be used in the cis or trans form.

The compounds of the present invention are prepared in the corresponding pharmaceutical compositions, even at belated release, for parenteral, oral and topical use, such for example sublingual, inhalatory, suppository, transdermal, enema, according to the well known techniques in the field, together with the usual excipients; see for example the volume "Remington's Pharmaceutical Sciences 15th Ed."

The amount on a molar basis of the active principle in these compositions is generally the same, or lower, compared with that of the corresponding precursor drug.

The daily administrable doses are those of the precursor drugs, or optionally lower. The daily precursor doses can be found in the publications of the field, such for example "Physician's Desk Reference".

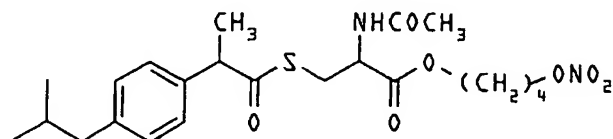
Among the invention compounds those preferred are the following:

2-acetyloxybenzoic acid 3-nitrooxymethyl phenyl ester (I<sup>c</sup>);  
2-fluoro-alpha-methyl[1,1'-biphenyl]-4-acetic acid 4-nitrooxy butylester (II<sup>c</sup>);

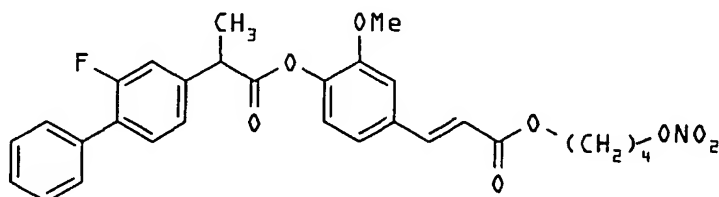


2-[(2,6-dichlorophenyl)amino]benzenacetic acid 4-nitrooxy butyl ester (III<sup>c</sup>);

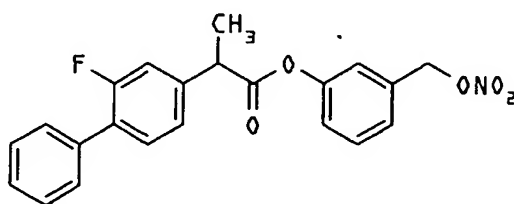
(S)-N-acetyl-[alpha-methyl-4-(2-methylpropyl)benzenacetyl] cysteine 4-nitrooxybutylester having formula:

(IV<sup>c</sup>)

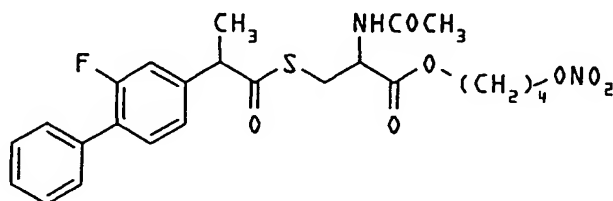
4-nitrooxybutanoic acid 4-acetylaminophenylester (V<sup>c</sup>);  
trans-3-[4-[2-fluoro-alpha-methyl(1,1'-biphenyl)-4-acetyloxy]-3-methoxyphenyl]-2-propenoic acid 4-(nitrooxy)butyl ester, having formula:

(VI<sup>c</sup>)

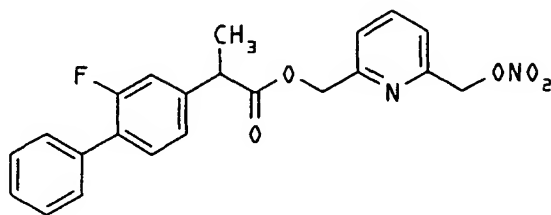
2-Fluoro-alpha-methyl[1,1'-biphenyl]-4-acetic acid 3-(nitrooxymethyl)phenyl ester having formula:

(VII<sup>c</sup>)

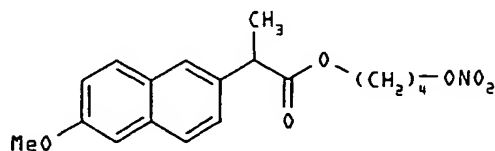
(S)-N-acetyl-[2-fluoro-alpha-methyl(1,1'-biphenyl)-4-acetyl] cysteine 4-(nitrooxy)butyl ester having formula:

(VIII<sup>c</sup>)

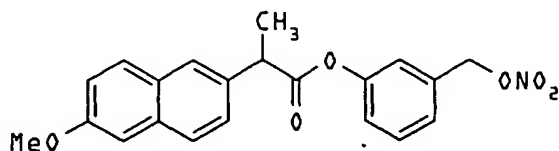
2-Fluoro-alpha-methyl[1,1'-biphenyl]-4-acetic acid 6-(nitrooxy methyl)-2-methylpyridyl ester having formula:

(XI<sup>c</sup>)

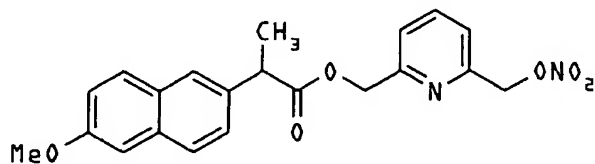
(S)-6-methoxy-alpha-methyl-2-naphthalenacetic acid 4-(nitrooxy) butyl ester having formula:

(X<sup>c</sup>);

(S)-6-methoxy-alpha-methyl-2-naphthalenacetic acid 3-(nitrooxy methyl)phenyl ester having formula:

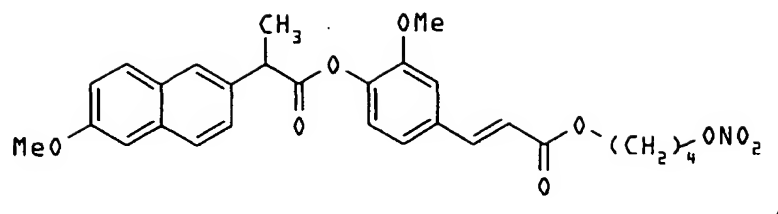
(XI<sup>b</sup>)

(S)-6-methoxy-alpha-methyl-2-naphthalenacetic acid 6-(nitrooxymethyl)-2-methylpyridyl ester having formula:

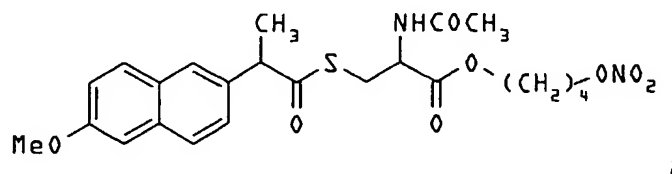


(XIId)

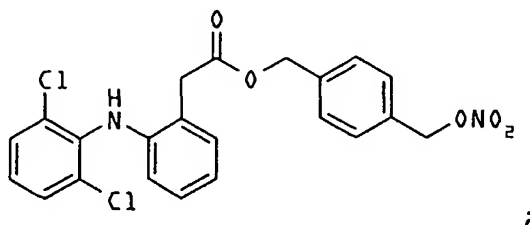
trans-3-[4-[6-methoxy-alpha-methyl-2-naphthalenacetyl oxy]-3-methoxyphenyl]-2-propenoic acid 4-(nitrooxy)butyl ester having formula:

(XIII<sup>c</sup>)

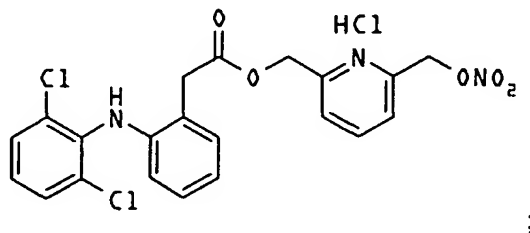
(S,S)-N-acetyl-S-(6-methoxy- $\alpha$ -methyl-2-naphthaleneacetyl) cysteine 4-(nitrooxy)butyl ester having formula:

(XIV<sup>c</sup>)

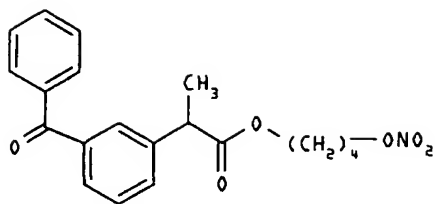
2-[(2,6-dichlorophenyl)amino]benzenacetic acid 4-(nitrooxy methyl)phenylmethyl ester having formula:

(XV<sup>c</sup>)

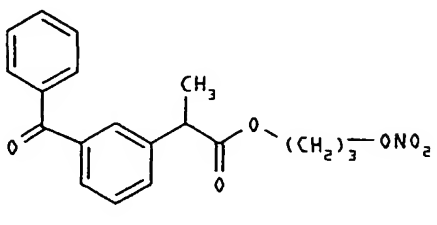
2-[(2,6-dichlorophenyl)amino]benzenacetic acid 6-(nitro oxymethyl)-2-methylpyridyl hydrochloride ester having formula:

(XVI<sup>c</sup>)

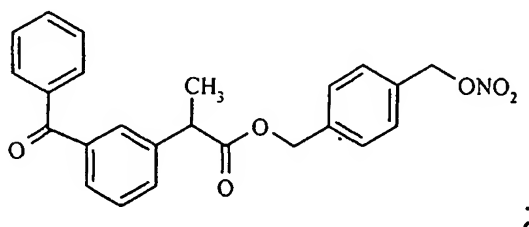
(S)-3-benzoyl- $\alpha$ -methyl-benzenacetic acid 4-(nitrooxy butyl) ester having formula:

(XVII<sup>c</sup>)

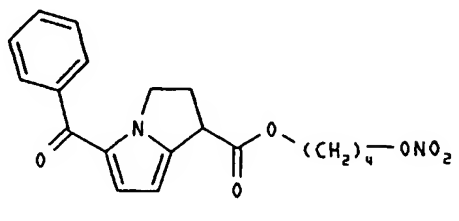
(S)-3-benzoyl- $\alpha$ -methyl-benzenacetic acid 3-(nitrooxy propyl) ester having formula:

(XVIII<sup>c</sup>)

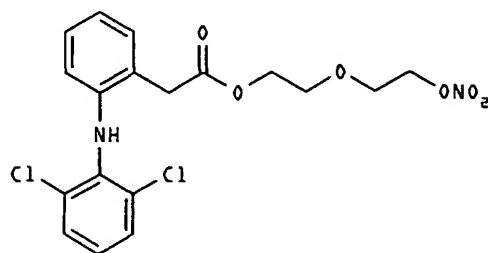
(S)-3-benzoyl- $\alpha$ -methyl-benzenacetic acid 4-(nitrooxy methyl) phenylmethyl ester having formula:

(XIX<sup>c</sup>)

5-benzoyl-2,3-dihydro-1H-pyrrolizine-1-carboxylic acid 4-(nitrooxy)butyl ester having formula:

(XXI<sup>c</sup>)

2-[(2,6-dichlorophenyl)amino]benzenacetic acid 5 (nitrooxy) ethyloxyethyl ester having formula:



(XX<sup>C</sup>)

1-(4-Chlorobenzoyl)-5-methoxy-2-methyl-1H-indole-3-acetic acid 3-(nitrooxymethyl)phenyl ester (XXI<sup>C</sup>).

It is surprising that the invention compounds are capable to promote the formation of the TGF-beta growth factor since it is known that the corresponding precursor compounds have no efficacy in reducing or preventing the cartilage degeneration process in the arthritic disease. Besides the Applicant has found that the NSAIDS precursor compounds have no effect on the formation of said growth factors.

Furthermore the present invention compounds have no side effects at gastric level and show an improved hepatic tolerability compared with the precursors. As an example, the Applicant has shown that the paracetamol nitroxybutylester has much more limited effects on the transaminase and bilirubin plasmatic levels compared with the paracetamol precursor.

Therefore the present invention compounds can be used in the arthritis therapy to prevent the cartilaginoid matrix degeneration, i.e. as curative and not only symptomatic drugs, combined with improved general tolerability.

The present invention compounds can be used also in the bony metabolism disease therapy, for example growth illness, characterized by an accelerated loss of the bony tissue, such as for example in old people.

It is known that the progressing of arthritic disease is due to the imbalance between pro-inflammatory (like IL-6, TNF- $\alpha$ ) and anti-inflammatory (like TGF- $\beta$  for example) media-

tors in different cells involved in the inflammation process, like monocytes, lymphocytes, chondrocytes, etc.

IL-6 (interleukin-6) is a potent pro-inflammatory cytokine and has been recognized to be implicated in rheumatoid arthritis (Choy E. H. et al., Arthritis Rheum. 46, 3143, 2002).

TNF $\alpha$  (Tumor necrosis factor  $\alpha$ ) has been shown to exert inflammatory changes in chondrocytes, such as decreased cell proliferation and decreased proteoglycan synthesis. Overall these effects can be considered as signs of cartilage degradation and be implicated in the pathogenesis of arthritis.

Thus the effectiveness of a compound to inhibit TNF $\alpha$  induced-inflammatory changes in chondrocytes can be considered as a measure of the activity on arthritis, since the pharmacological action is to maintain the cartilage matrix integrity.

The compounds of the present invention are effective in reducing or eliminating the imbalance above said. They increase the formation of the anti-inflammatory mediators and decrease of the production of pro-inflammatory mediators.

Thus they have a more favourable pharmacotherapeutic profile than single cytokine-neutralizing agents (anti-TNF, etc) that must be given at very high doses, thus resulting in toxicity.

In rheumatoid arthritis disease a vast majority of patients have intermittent relapses and remissions of the disease. Unlike conventional NSAIDs administration of the drugs of the present invention can prevent disease relapses.

The following Examples are for illustrative purposes and are not limitative of the invention.

#### **EXAMPLE F1**

Chondrocytes have been isolated from calf cartilage as described in Benya P.D., Biochemistry 1977; 16; 865-872, and used as primary cultures. The primary cultures have been kept in a DMEM culture medium (Dulbecco's modified Eagle medium)

(high glucose) containing bovine fetal serum (10% vol.) and antibiotics at 37°C and in air/CO<sub>2</sub> atmosphere (95%/5% vol.) until reaching the culture confluence. A cell sample is kept as a control and not treated with the tested compounds. The tested compounds are added to the other cellular cultures at the concentration 10<sup>-5</sup> M and the so treated cultures have been incubated for 24 hours. The compounds have been previously dissolved in a DMSO amount such that the final concentration in the medium is 0.1%. The control has been treated only with DMSO.

The used compounds have been the following:

- 2-acetyloxybenzoic acid 3-nitrooxymethyl phenyl ester (NO-aspirin) prepared as described in Example 3 of WO 97/16405.
- 2-fluoro-alpha-methyl[1,1'-biphenyl]-4-acetic acid 4-nitrooxybutylester (NO-flurbiprofen), prepared as describe in Example 1 of WO 94/12463.
- 2-[(2,6-dichlorophenyl)amino]benzenacetic acid 4-nitrooxybutyl ester (NO-diclofenac), prepared as described in Example 1 of WO 94/04484.
- (S)-N-acetyl-[alpha-methyl-4-(2-methylpropyl)benzen-acetyl] cysteine 4-nitrooxybutylester (NO-ibuprofen), prepared as described in Example 2 of WO 00/6137.
- 4-nitrooxybutanoic acid 4-acetylaminophenylester (NO-paracetamol), prepared as described in Example 1 of WO 01/12584.

The following precursor compounds have been contemporaneously tested: aspirin and flurbiprofen.

At the end the cells have been washed 3 times with a medium free from serum and added with BSA (bovine serum albumin, 200 µg/ml) for 5, 30 and 60 minutes respectively and then incubated in a medium devoid of serum (1 ml) for further 6 hours. The conditioned medium has been collected, centrifuged and kept at -70°C until the use.

Before the experiment, 0.5 ml of cellular culture super-

natant have been acidified with HCl (0.1 ml, 1 N) and incubated at room temperature for 10 min, then neutralized with NaOH/HEPES (0.1 ml NaOH 1.2N / 0.5 M).

CCL-64 cellular cultures lines in a proliferative state have been prepared as described in Jennings J. C., J. Cell. Physiol. 1988, 137, 167-72, sowing  $2 \times 10^4$  cells/well and incubating in the presence of FCS-medium (10% vol.).

After 24 hours the cells have been washed with the medium free from serum and incubated for 24 hours, respectively, with 0.5 ml of conditioned condrocyte medium, prepared as above and with increasing concentrations of TGF- $\beta$ 1 to determine a cellular growth inhibition reference curve, since the growth of said cellular lines is inhibited by the presence of TGF- $\beta$ 1.

At the twentieth hour  $^3\text{H}$ -timidine (0.5  $\mu\text{Ci/ml}$ ), a cellular proliferation marker, which is incorporated in the DNA of the new cells has been added to the cultures. The cultures have then been incubated for 4 hours.

At the end the cells have been cold fixed ( $5^\circ\text{C}$ ) with tri-chloroacetic acid 5% v/v, washed with the same solution and dissolved in NaOH (0.1 N). On the cells the count in liquid scintigraphy has been carried out to measure the marked timidine incorporated in the samples and in the standards treated with increasing amounts of TGF- $\beta$ 1. From the amount of incorporated timidine it is shown the amount of TGF- $\beta$ 1. The data reported in Table 1 are expressed in percentage of TGF $\beta$ 1 produced in the samples treated with the tested compounds, compared with the untreated control. The data show that the tested compounds induce in the chondrocytes a significant increase of the TGF $\beta$ 1 production compared with the untreated controls and the precursor compounds, and that the present invention compounds can therefore be used to prevent or reduce the articular tissue degradation.

#### **EXAMPLE F2**

Hepatic tolerability of paracetamol v. the corresponding nitrooxybutylester (NO paracetamol)



The nitrooxybutylester of paracetamol (NO-paracetamol) has been prepared as described in Example F1.

Groups of No. 10 rats have been treated i.p. with NO-paracetamol (1.4 g/Kg i.p.) or with paracetamol (1.16 g/Kg) or with the carrier (0.9% w/v NaCl containing 20% v/v di tween-20) (control group).

After 6 hours from the administration, the animals have been sacrificed, the blood has been collected and the plasma analyzed to determine the aspartate aminotransferase (AST) and alanine aminotransferase (ALT) and bilirubin concentrations. The results are reported in Table 2 and have been expressed in percentage with respect to the values obtained in the control group (100%).

The results show that the paracetamol administration causes hepatic damage since there is an increase of the transaminase and bilirubin values with respect to the controls.

The NO-paracetamol administration does not cause ALT increase while the AST and bilirubin plasmatic levels are much lower than those of the groups treated with paracetamol, and as order of magnitude comparable with those of the controls.

#### **EXAMPLE F3**

Effect of NO-flurbiprofen and of flurbiprofen on interleukin (IL)-6 release in human monocytes (ex-vivo study)

IL-6 is a potent pro-inflammatory cytokine and has been recognized to be implicated in rheumatoid arthritis (Choy E.H. et al., Arthritis Rheum.46,3143,2002).

Twenty-four healthy subjects of both sexes were enrolled and randomised into three groups of 8 subjects each. Each group was administered as it follows:

- placebo : vehicle (0.5% aqueous suspension of carboxymethyl cellulose);
- flurbiprofen : 100 mg twice a day;
- NO-flurbiprofen :100 mg twice a day; the compound was prepared as described in example F1.

The treatment lasted seven consecutive days (oral subacute treatment).

Monocytes from whole blood samples obtained before and 4 hours after the last treatment were prepared. Monocytes were extracted by positive selection using paramagnetic beads loaded with anti-CD11 antibody. Cells were then incubated with 10 µg/ml endotoxin for 24 hours, and IL-6 released in cell supernatant measured by ELISA assay.

Results are reported in Table 3. Results are given as % in the confront of IL-6 release obtained in the placebo group.

The Table shows that oral subacute treatment of NO-flurbiprofen, but not of flurbiprofen, markedly suppressed IL-6 release in monocytes

#### **EXAMPLE F4**

Effect of flurbiprofen, NO-flurbiprofen, indomethacin, NO-indomethacin (indomethacin (3-nitrooxymethyl)phenyl ester) on interleukin (IL)-6 and TGF-β release in mouse spleen lymphocytes (in vitro study)

Spleen lymphocytes were prepared as it follows. Mice were killed by an overdose of ether, and spleens were collected and maintained in a sterile RPMI medium (Sigma-Aldrich) containing 0.5% (vol/vol) L-glutamine and 0.5 % (vol/vol) sterile endotoxin-free fetal calf serum (FCS). The spleens were opened and the content (whole cells) collected and diluted with RPMI.

After repeated washings, cells were suspended in 10 ml of RPMI containing 1% (vol/vol) streptomycin and 1% (vol/vol) penicillin. The suspension was then incubated at 37° C for 24 hours, in an O<sub>2</sub>/CO<sub>2</sub> atmosphere (95%/5% v/v). Monocytes were eliminated by adhesion, and lysis of red cells was obtained by suspension in a solution 0.15 mol/liter NH<sub>4</sub>Cl and 1 mmol/liter KHCO<sub>3</sub>. The resulting lymphocytes were resuspended in RPMI-FCS, incubated for 30 minutes at 37°C with anti-FAS, anti-FASL, or anti-IL<sub>2</sub> receptor monoclonal antibodies, and then washed twice with RPMI-FCS. Cells were then incubated with the FITC-

conjugated secondary antibody for 30 mins at 4°C, washed twice, and resuspended in PBS/formaldehyde (0.5%). Control samples were treated with the FITC-conjugated secondary antibody only. Stained cells were analysed on a flow cytofluorimeter. Cells were gated using forward vs side scatter to exclude dead cells and debris.

Cells were transferred in plate and then 10 µg/ml endotoxin and each of the following compounds at a concentration of 50 µM added:

- Placebo (no compound added);
- Flurbiprofen;
- NO-Flurbiprofen; the compound was prepared as described in ex. F1, above;
- Indomethacin;
- NO-indomethacin; the compound was prepared as described in the example on page 45 of WO 98/09948;

then it was incubated for 24 hours

IL-6 and TGF-β released in cell supernatant was measured by ELISA assay, taking as 100% release that of placebo group.

The results obtained are reported in Table 4.

The Table shows that both, NO-flurbiprofen and NO-indomethacin inhibit the release of IL-6 and potentiate the release of TGF-β.

#### **EXAMPLE F5**

Effect of flurbiprofen, NO-flurbiprofen, ibuprofen, NO-ibuprofen on human chondrocytes and proteoglycan synthesis (in vitro study)

Human chondrocytes were isolated by collagenase digestion from knee cartilage collected from patients undergoing knee replacement surgery. Only primary culture was used to avoid phenotype change of human chondrocytes. TNFα (80 ng/ml) was added to all but control cells. Test compounds were dissolved at a concentration 0.02% (w/v) in DMSO (vehicle).

The following compounds were tested:

- Flurbiprofen;

- NO-flurbiprofen, prepared as described in ex. F1;
- Ibuprofen;
- NO-ibuprofen, prepared as described in ex. F1.

The test compounds were incubated with cells at a 100  $\mu$ M concentration for 24 hours.

Cell proliferation was determined by measuring [ $^3$ H]-thymidine incorporated into newly synthesized DNA. Cell viability was assessed by MTS assay kit.

Proteoglycan synthesis was determined by [ $^{35}$ S]-sulfate incorporation. Cells and supernatant were extracted with 4M guanidinium chloride and purified by Sephadex columns chromatography. The amount of [ $^{35}$ S]-sulfate was measured by liquid scintillation counter. Results were normalized by the amount of Dna in the sample and expressed as CPM/ $\mu$ g DNA (CPM = count per minute).

The results are reported in Table 5 and are expressed as % cell growth/proteoglycan synthesis with respect to the control group.

The Table shows that NO-flurbiprofen and NO-ibuprofen reversed the decrease of cell proliferation induced by TNF $\alpha$ . No effect on cell viability was found. Both NO compounds reversed the decrease in proteoglycan synthesis induced by TNF $\alpha$ . The parent NSAIDs did not affect TNF $\alpha$ -induced effects on cell proliferation and proteoglycan synthesis. In both experiments the activity of the parent compounds was almost the same as that of the vehicle.

#### **EXAMPLE F6**

Effect of flurbiprofen, NO-flurbiprofen, paracetamol and NO-paracetamol on the expression of TGF- $\beta$  type II receptor.

Type II collagen and TGF- $\beta$  type II receptor (TBR II) expression have been reported as agents playing a crucial role in osteoarthritis (OA) physiopathology. Indeed, in experimental models of OA it was found that the physiological levels of said agents are dramatically decreased. This could be one

of the main reasons why OA cartilage erosion continues irreversibly (Osteoarthritis and Cartilage, 1998, 6, 146-149).

The steady-state levels of mRNA for type II collagen and TGF- $\beta$  type II receptor (T $\beta$ RII) was evaluated in human articular chondrocytes (HAC), cultured in hypoxia (5 % v/v O<sub>2</sub>). The cells were treated or not with interleukin-1 $\beta$  (IL-1 $\beta$ ) an agent favouring OA pathology, and NO-NSAIDs, or the corresponding NSAIDs at 10<sup>-5</sup> M for 48 h.

The following compounds were tested:

- flurbiprofen;
- NO-flurbiprofen, prepared as described in ex. F1;
- Paracetamol;
- NO-paracetamol, prepared as described in ex. F1.

It was found that NO-flurbiprofen increased type II collagen mRNA levels (more than 100%) whereas flurbiprofen had no significant effect.

Furthermore NO-paracetamol and NO-flurbiprofen strongly increased T $\beta$ RII (more than 100 %) whereas their corresponding NSAIDs had no effect.

The nitrooxy derivatives according to the present invention stimulate the expression of TGF- $\beta$  receptor type II and therefore delay the onset or evolution of OA.

Table 1

Stimulation of the TGF $\beta$ 1 production in cellular chondrocyte cultures to which the compounds mentioned below have been added. The results are expressed in percentage of TGF $\beta$ 1 produced in the samples treated with respect to the untreated control.	
Compound	% of produced TGF $\beta$ 1
Controls	100
NO-Aspirin	600
Aspirin (comp)	150
NO-Flurbiprofen	650
Flurbiprofen (comp)	120
NO-Diclofenac	550
NO-Ibuprofen	700
NO-Paracetamol	350

Table 2

Evaluation of the hepatic tolerability (AST, ALT and bilirubin concentration) in consequence of the administration to rats of NO-paracetamol and paracetamol. The reported values are expressed in % with respect to those of the controls			
Treatment	AST %	ALT %	Bilirubin %
Carrier	100	100	100
Paracetamol (comp)	330	171	200
NO-paracetamol	160	57	136

Table 3

Example F3 : effect of flurbiprofen and NO-flurbiprofen on IL-6 release in human monocytes. Results are given as % in the confront of IL-6 release obtained in the placebo group.	
Treatment	IL-6 release % in the confront of placebo
Placebo	100
Flurbiprofen (comp)	100
NO-flurbiprofen	10

Table 4

Example F4 : effect of flurbiprofen, NO-flurbiprofen, indomethacin, NO-indomethacin on IL-6 and TGF- $\beta$ release in mouse spleen lymphocytes.		
Treatment	IL-6 release % in the confront of placebo	TGF- $\beta$ release % in the confront of placebo
Placebo	100	100
Flurbiprofen (comp)	100	115
NO-flurbiprofen	10	150
Indomethacin (comp)	90	70
NO-indomethacin	20	130

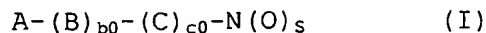


Table 5

Example F5 : effect of flurbiprofen, NO-flurbiprofen, ibuprofen, NO-ibuprofen on cell proliferation and proteoglycan synthesis.		
Treatment	Cell proliferation % in the confront of control	Proteoglycan synthesis % in the confront of control
Control	100	100
Vehicle	50	22
Flurbiprofen (comp)	53	26
NO-flurbiprofen	90	70
Ibuprofen (comp)	48	24
NO-ibuprofen	95	55

## CLAIMS

1. Use for the preparation of disease-modifying drugs drugs for the prevention and treatment of arthritis therapy of compounds or salts thereof having the following general formula:



wherein:

s is an integer and is equal to 1 or 2, preferably 2;

c0 is an integer and is equal to 0 or 1;

b0 is an integer and is 0 or 1; with the proviso that at least one between c0 and b0 is different from zero;

A = R-T<sub>1</sub>-, wherein

R- is the radical of a non steroidal antiinflammatory precursor drug excluding the compounds having 2-oxo-1H-indolic structure, or the radical of a non steroidal antiinflammatory/analgesic drug;

T<sub>1</sub> = (CO)<sub>t</sub> or (X)<sub>t'</sub>, wherein X = -O-, -S-, -N(R<sub>1c</sub>)-, R<sub>1c</sub> is H or C<sub>1</sub>-C<sub>5</sub> linear or branched alkyl, t and t' are integers and equal to zero or 1, with the proviso that t = 1 when t' = 0; t = 0 when t' = 1;

B = -T<sub>B</sub>-X<sub>2</sub>-T<sub>BI</sub>- wherein

T<sub>B</sub> and T<sub>BI</sub> are equal or different;

T<sub>B</sub> = (CO) when the reactive function in the precursor drug is -OH or -NH(R<sub>1c</sub>); T<sub>B</sub> = X, as above, when the reactive function in the precursor drug is -COOH;

T<sub>BI</sub> = (CO)<sub>tx</sub> or (X)<sub>txx</sub>, wherein tx and txx have the value of 0 or 1; with the proviso that tx = 1 when txx = 0, tx = 0 when txx = 1; X is as above;

X<sub>2</sub> is a bivalent linking group as defined below;

C is the bivalent radical -T<sub>c</sub>-Y- wherein

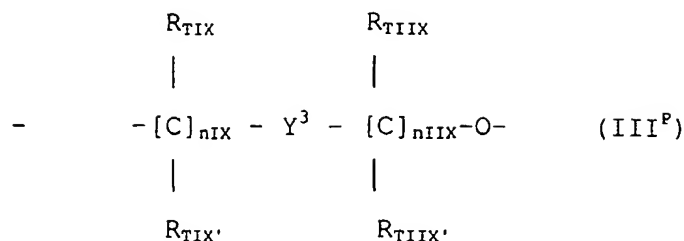
when b0 = c0 = 1: T<sub>c</sub> = (CO) when tx = 0, T<sub>c</sub> = X when txx = 0, X being as above;

when b0 = 0: T<sub>c</sub> = (CO) when t = 0, T<sub>c</sub> = X when t' = 0, X being as above;

when c0 = 0: tx = 0, T<sub>BI</sub> = X = -O-.

Y is:

Y<sub>p</sub>:



wherein:

nIX is an integer from 0 to 10, preferably from 1 to 3;

nIIX is an integer from 1 to 10, preferably from 1 to 3;

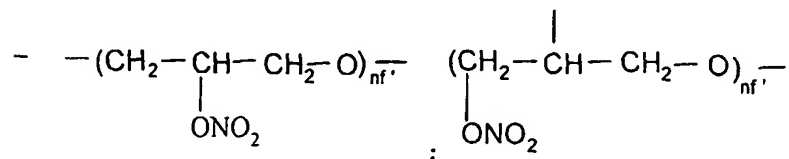
R<sub>TIX</sub>, R<sub>TIX'</sub>, R<sub>TIIX</sub>, R<sub>TIIX'</sub>, equal to or different from each other are H or C<sub>1</sub>-C<sub>4</sub> linear or branched alkyl; preferably R<sub>TIX</sub>, R<sub>TIX'</sub>, R<sub>TIIX</sub>, R<sub>TIIX'</sub> are H.

Y<sup>3</sup> is a saturated, unsaturated or aromatic heterocyclic ring containing one or two nitrogen atoms having 5 or 6 atoms,

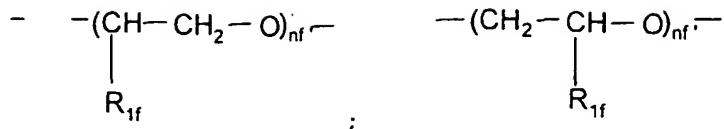
or Y can be:

Y<sub>0</sub>, selected from the following:

- a -R'O- alkyleneoxy group wherein R' is linear or branched when possible C<sub>1</sub>-C<sub>20</sub>, preferably having from 2 to 6 carbon atoms, or a cycloalkylene having from 5 to 7 carbon atoms, in the cycloalkylene ring one or more carbon atoms can be substituted by heteroatoms, the ring can have side chains of R' type, R' being as above; or one of the following groups:

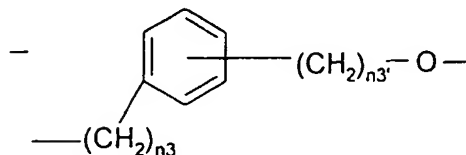


wherein nf' is an integer from 1 to 6 preferably from 1 to 4;

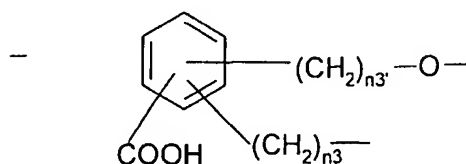


wherein  $\text{R}_{1f} = \text{H}, \text{CH}_3$  and  $n_f'$  is an integer from 1 to 6; preferably from 1 to 4;

or Y is  $\text{Y}_{Ar}$  and is selected from the following:



wherein  $n_3$  is an integer from 0 to 3 and  $n_3'$  is an integer from 1 to 3;



wherein  $n_3$  and  $n_3'$  have the above meaning;

$\text{X}_2$ , bivalent radicalm is such that the corresponding precursor of B,  $-\text{T}_B-\text{X}_2-\text{T}_{Bf}-$  wherein the free valences of  $\text{T}_B$  and of  $\text{T}_{Bf}$  are saturated each with  $\text{OZ}$ , with  $\text{Z}$  or with  $-\text{N}(\text{Z}^{\text{I}})(\text{Z}^{\text{II}})$ , wherein  $\text{Z} = \text{H}, \text{C}_1-\text{C}_{10}$ , preferably  $\text{C}_1-\text{C}_5$  linear or branched when possible alkyl,  $\text{Z}^{\text{I}}, \text{Z}^{\text{II}}$  equal or different have the Z values as above, depending on that  $\text{T}_B$  and/or  $\text{T}_{Bf} = \text{CO}$  or  $\text{X}$ , in function of the values of  $t, t', tx$  and  $txx$ ;

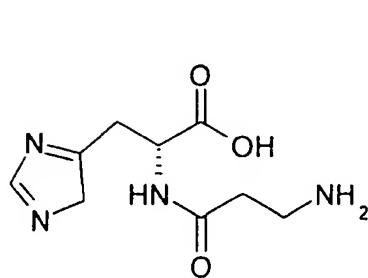
the precursor of B is selected from the following:

- aminoacids,
- hydroxyacids,
- aromatic and heterocyclic mono- and polyalchols,
- compounds containing at least one free acid function.

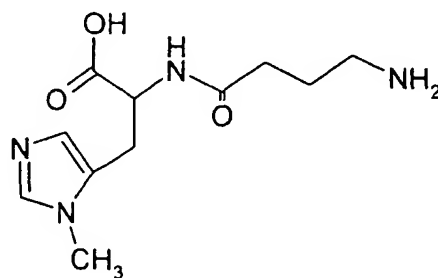
2. Use according to claim 1, wherein the precursor of B is selected from the following:

- aminoacids selected from the following: L-

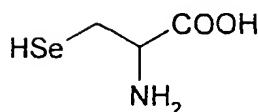
carnosine (formula CI), anserine (CII), selenocysteine (CIII), selenomethionine (CIV), penicillamine (CV), N-acetylpenicillamine (CVI), cysteine (CVII), N-acetylcysteine (CVIII), glutathione (CIX) or esters thereof, preferably ethyl or isopropyl ester:



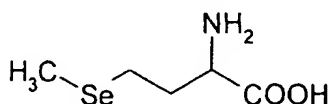
(CI)



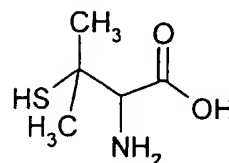
(CII)



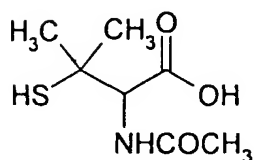
(CIII)



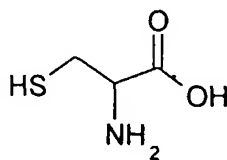
(CIV)



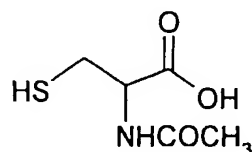
(CV)



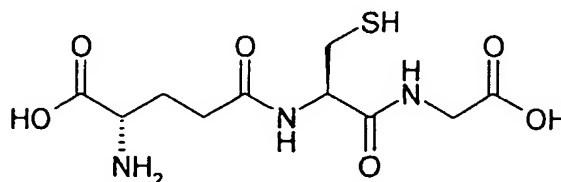
(CVI)



(CVII)

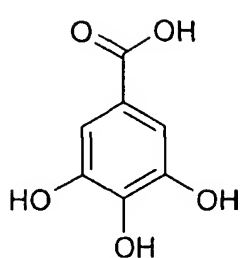


(CVIII)

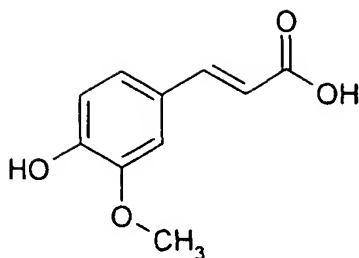


(CIX)

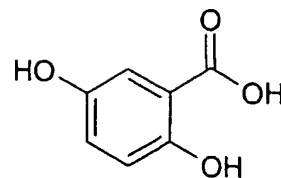
- hydroxyacids, selected from the following: gallic acid (formula DI), ferulic acid (DII), gentisic acid (DIII), citric acid (DIV), caffeic acid (DV), dihydrocaffeic acid (DVI), p-cumaric acid (DVII), vanillic acid (DVIII):



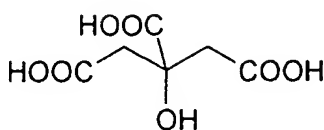
(DI)



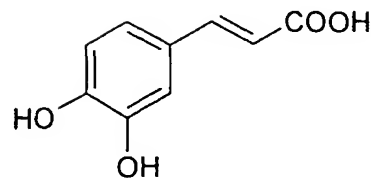
(DII)



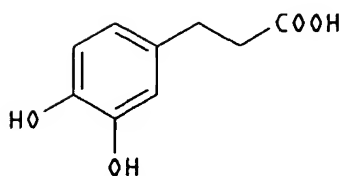
(DIII)



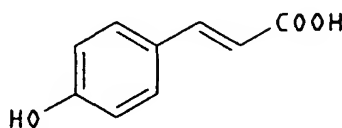
(DIV)



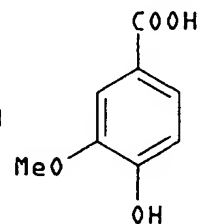
(DV)



(DVI)

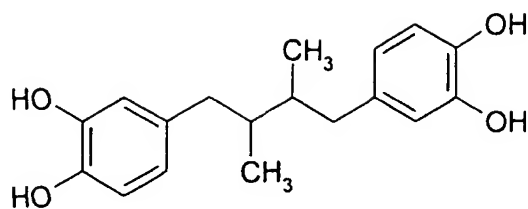


(DVII)

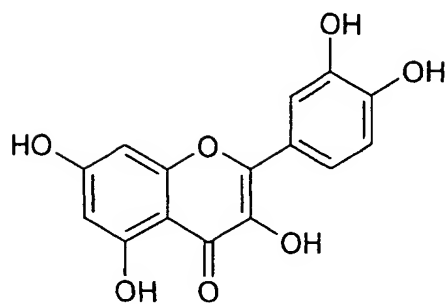


(DVIII)

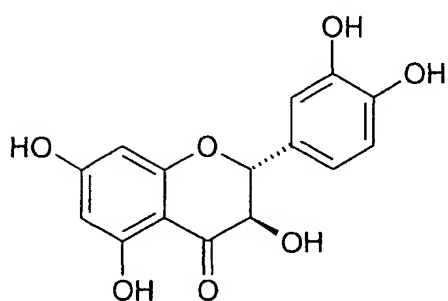
- aromatic and heterocyclic mono- and polyalcohols, selected from the following: nordihydroguaiaretic acid (EI), quercetin (EII), catekin (EIII), kaempferol (EIV), sulphurethyne (EV), hydroquinone (EVIII), gossypol (EIX), reductic acid (EX), methoxyhydroquinone (EXI), hydroxyhydroquinone (EXII), propyl gallate (EXIII), 3,5-di-ter-butyl-4-hydroxybenzyl-thioglycolate (EXXIV), allopurinol (EXXI); saccharose (EC), ascorbic (ECI) and isoascorbic acid (ECII), p-cumaric alcohol (ECIII), 4-hydroxy-phenylethylalcohol (ECIV), coniferyl alcohol (ECV):



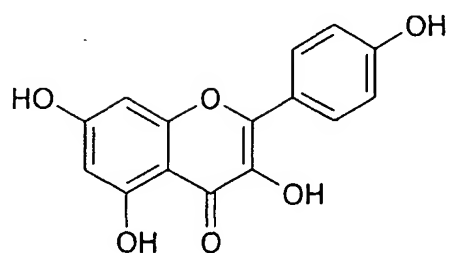
(EI)



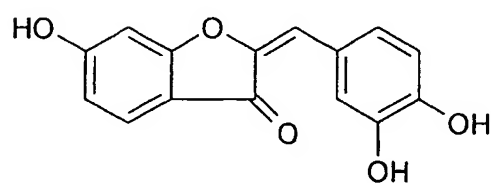
(EII)



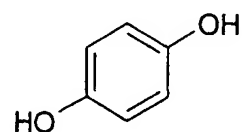
(EIII)



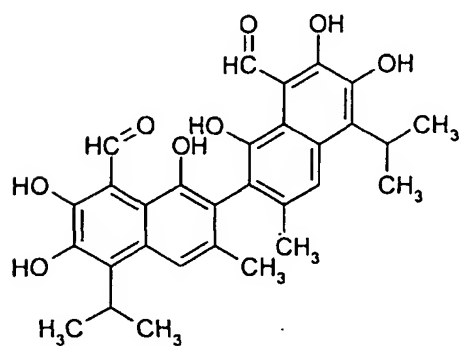
(EIV)



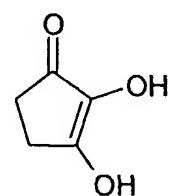
(EV)



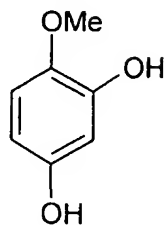
(EVIII)



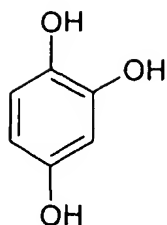
(EIX)



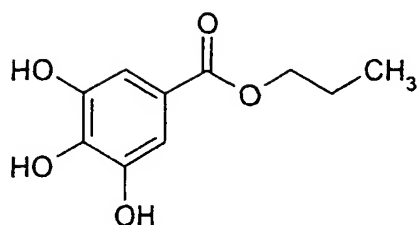
(EX)



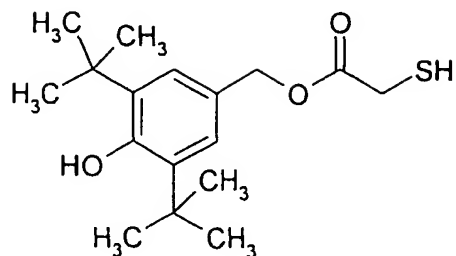
(EXI)



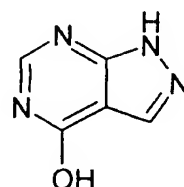
(EXII)



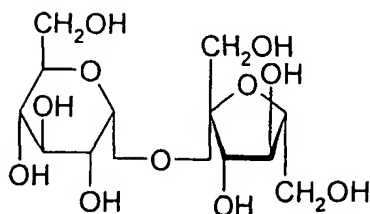
(EXIII)



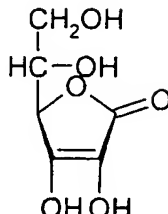
(EXXIV)



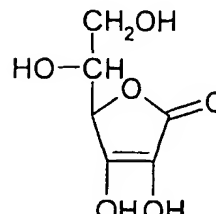
(EXXXI)



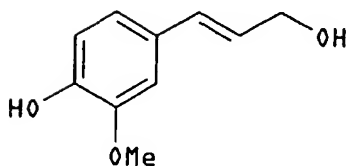
(EC)



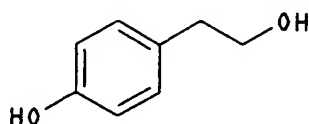
(ECI)



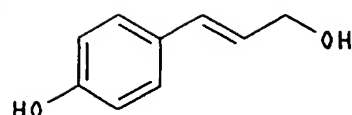
(ECII)



(ECIII)

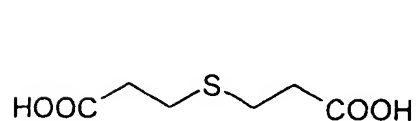


(ECIV)

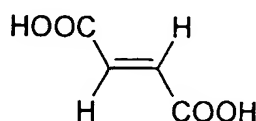


(ECV)

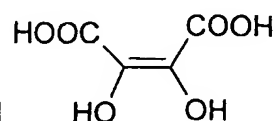
- compounds containing at least one free acid function, selected from the following: 3,3'-thiodipropionic acid (NI), fumaric acid (NII), dihydroxymaleic acid (NIII), edetic acid (NV):



(NI)

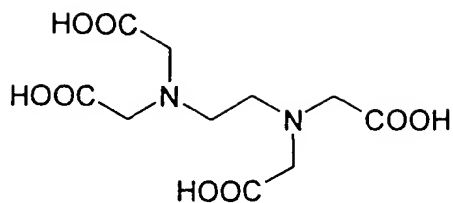


(NII)



(NIII)



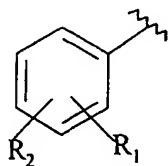


(NV)

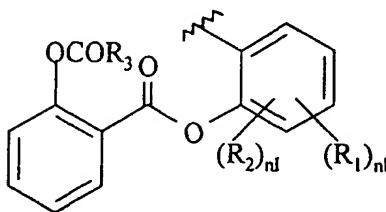
3. Use according to claims 1-2, wherein in the compounds of formula (I) when  $b_0 = c_0 = 1$ , the bonds between the drug radical and  $X_2$  and between  $X_2$  and  $Y$  are, independently the one from the other, of ester, thioester, amide type; when  $b_0 = 0$  and  $c_0 = 1$  the bond between the drug radical and  $Y$  is of ester, thioester, amide type.
4. Use according to claims 1-3, wherein the R radical is selected from the following groups:

Group I)

Ia)



Ib)



wherein:

$R_1$  is H or  $-OCOR_3$ ; wherein  $R_3$  is methyl, ethyl or  $C_3$ - $C_5$  linear or branched alkyl, or the residue of an heterocycle with only one ring having 5 or 6 atoms partially or totally hydrogenated, or aromatic, containing one or more heteroatoms independently selected from O, N and S;

$R_2$  is hydrogen, hydroxy, halogen,  $C_1$ - $C_4$  linear or branched alkyl,  $C_1$ - $C_4$  linear or branched alkoxy; a  $C_1$ - $C_4$  linear or

branched perfluoroalkyl, for example trifluoromethyl; nitro, amino, mono- or di-(C<sub>1-4</sub>) alkylamino;

with the proviso that in formula Ia) R<sub>1</sub> and R<sub>2</sub> are not contemporaneously H; preferably when R<sub>1</sub> = H R<sub>2</sub> = OH;

preferably in the compounds of formula Ia) T<sub>1</sub> = -CO- and:

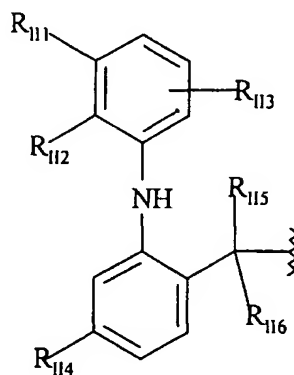
- R<sub>1</sub> = acetoxy, preferably in ortho position with respect to -CO-, R<sub>2</sub> is hydrogen; in this case the formula Ia) represents the acetylsalicylic acid residue;
- R<sub>1</sub> = H R<sub>2</sub> = OH, preferably in ortho position with respect to -CO-, in this case the formula Ia) represents the salicylic acid residue;

in formula Ib) nI is an integer 0 or 1;

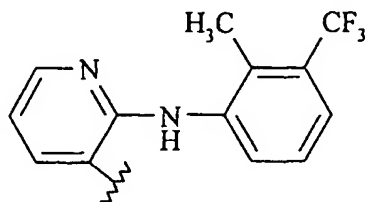
preferably in the compounds of formula Ib) R<sub>3</sub> = CH<sub>3</sub>, nI = 0, T<sub>1</sub> = -CO-; in this case Ib) is the acetylsalicylsalicylic acid residue;

Group II)

IIa)



IIb)



wherein:

$R_{II5}$  is H,  $C_1-C_3$  linear or branched when possible alkyl;

$R_{II6}$  has the same meaning as  $R_{II5}$ , or when  $R_{II5}$  is H it is benzyl;

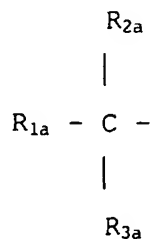
$R_{II1}$ ,  $R_{II2}$  and  $R_{II3}$  are independently hydrogen,  $C_1-C_6$  linear or branched alkyl, or  $C_1-C_6$  linear or branched alkoxy, or Cl, F, Br;

$R_{II4}$  is  $R_{II1}$  or bromine;

the compounds are preferred wherein  $R_{II1}$ ,  $R_{II4}$  are hydrogen and  $R_{II2}$  and  $R_{II3}$  are chlorine in ortho position with respect to NH;  $R_{II5}$  and  $R_{II6}$  are H,  $T_1 = -CO-$ , when the free valence is saturated with OH the precursor compound is known as diclofenac.

I Ib) is the residue of the 2-[(2-methyl-3-(trifluoromethyl)phenyl)amino]-3-pyridincarboxylic acid when  $T_1 = -CO-$  and the free valence is saturated with OH the compound is known as flunixin;

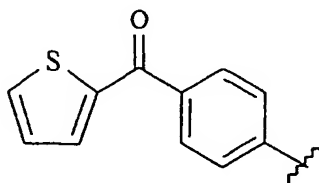
Group III) wherein R is:



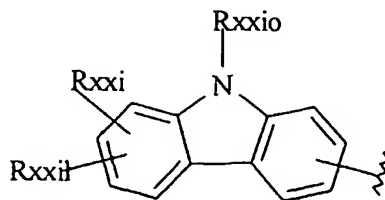
wherein:

$R_{2a}$  and  $R_{3a}$  are H,  $C_1-C_{12}$  linear or branched, substituted or not, alkyl or allyl, with the proviso that when one of the two is allyl the other is H; preferably  $R_{2a}$  and  $R_{3a}$ , equal or different, are H,  $C_1-C_4$  alkyl;

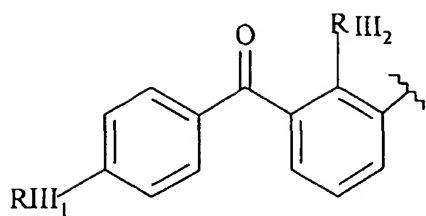
$R_{1a}$  is selected from:



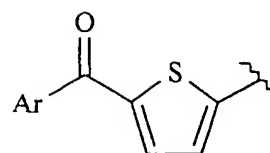
(II)



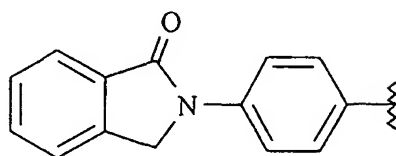
(XXI)



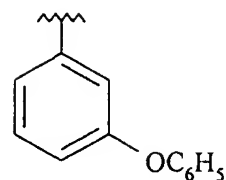
(IV)



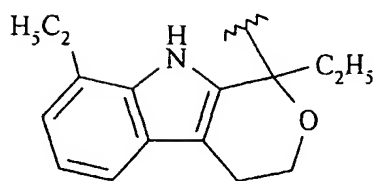
(XXXV)



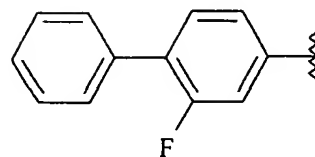
(VI)



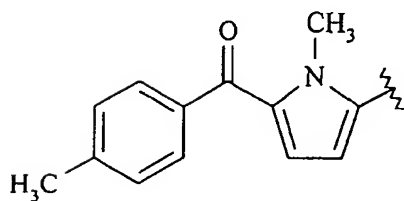
(VII)



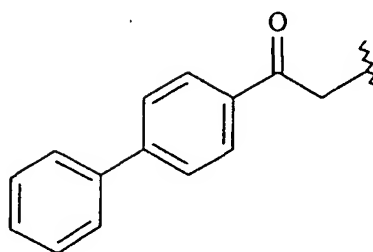
(VIII)



(IX)

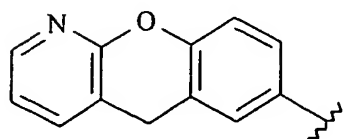


(X)

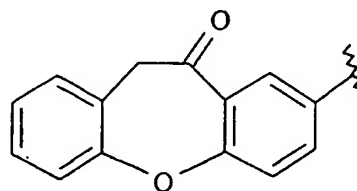


(III)

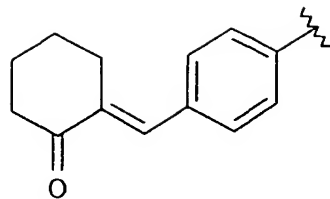
IIID) R<sub>1a</sub> corresponds to the following formulas:



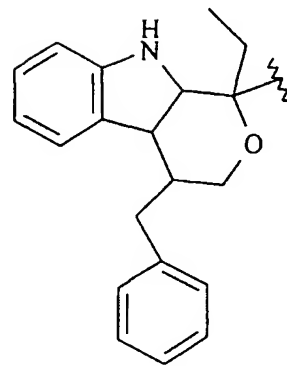
(IIIa)



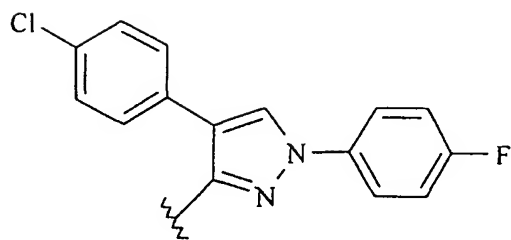
(XXX)



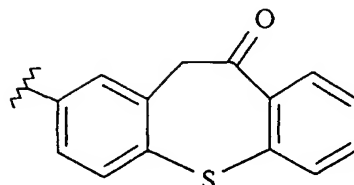
(XXXI)



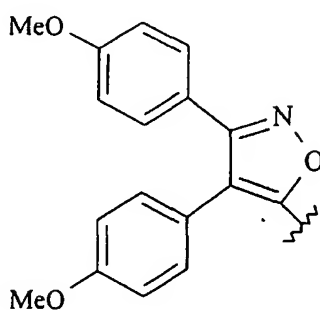
(XXXII)



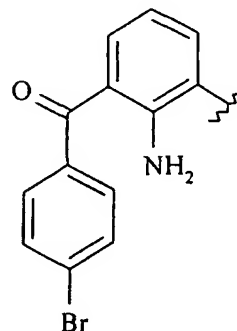
(XXXIII)



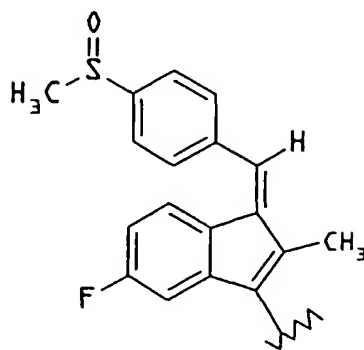
(XXXVI)



(XXXVII)



(XII)



(XXXX)

wherein the meanings are the following:

- when  $R_{1a}$  is as defined in formula (IV), Ketoprofen residue:  
 $R_{III1}$  is H,  $SR_{III3}$  wherein  $R_{III3}$  is  $C_1$ - $C_4$  linear or branched alkyl;  
 $R_{III2}$  is H, hydroxy;  
the compounds wherein  $R_{III1}$  and  $R_{III2}$  are H,  $R_{3a}$  is H, and  $R_{2a}$  is methyl,  $T_1 = -CO-$  are preferred;
- when  $R_{1a}$  is as defined in formula (XXI), carprofen residue:  
 $R_{xxio}$  is H, alkyl from 1 to 6 C atoms linear or branched,  $C_1$ - $C_6$  alkoxy carbonyl linked to a  $C_1$ - $C_6$  alkyl,  $C_1$ - $C_6$  carboxyalkyl,  $C_1$ - $C_6$  alkanoyl, optionally substituted with halogens, benzyl or halobenzyl, benzoyl or halobenzoyl;  
 $R_{xxi}$  is H, halogen, hydroxy, CN,  $C_1$ - $C_6$  alkyl containing or not containing OH groups,  $C_1$ - $C_6$  alkoxy, acetyl, benzyloxy,  $SR_{xxi2}$  wherein  $R_{xxi2}$  is  $C_1$ - $C_6$  alkyl;  $C_1$ - $C_3$  perfluoroalkyl;  $C_1$ - $C_6$  carboxyalkyl containing or not containing OH groups,  $NO_2$ , amino; sulphamoyl, di-alkyl sulphamoyl with  $C_1$ - $C_6$  alkyl, or di-fluoroalkylsulphonyl with  $C_1$ - $C_3$  alkyl;  
 $R_{xxi1}$  is halogen, CN,  $C_1$ - $C_6$  alkyl containing one or more OH groups,  $C_1$ - $C_6$  alkoxy, acetyl, acetamido, benzyloxy,  $SR_{III3}$  being  $R_{III3}$  as above,  $C_1$ - $C_3$  perfluoroalkyl, hydroxy,  $C_1$ - $C_6$  carboxyalkyl,  $NO_2$ , amino,  $C_1$ - $C_6$  mono- or di-alkyl-amino; sulphamoyl,  $C_1$ - $C_6$  di-alkyl-sulphamoyl, or di-fluoroalkylsulphamoyl as above; or  $R_{xxi}$  together with  $R_{xxi1}$  is a  $C_1$ - $C_6$  alkylenedioxy;  
the compounds are preferred wherein  $R_{xxio}$  is H, the linking group is in position 2,  $R_{xxi}$  is H,  $R_{xxi1}$  is chlorine and is in para position with respect to the nitrogen;  
 $R_{3a}$  is H,  $R_{2a}$  is methyl and  $T_1 = -CO-$ ;
- when  $R_{1a}$  is as defined in formula (XXXV) tiaprofenic acid residue:

Ar is phenyl, hydroxyphenyl optionally mono- or polysubstituted with halogen, alkanoyl and C<sub>1</sub>-C<sub>6</sub> alkoxy, C<sub>1</sub>-C<sub>6</sub> trialkyl, preferably C<sub>1</sub>-C<sub>3</sub>, cyclopentyl, cyclohexyl, cycloheptyl, heteroaryl, preferably thienyl, furyl containing or not containing OH, pyridyl;

the preferred compounds of (XXXV) are those wherein Ar is phenyl, R<sub>3a</sub> is H, R<sub>2a</sub> is methyl and T<sub>1</sub> = -CO-;

- when R<sub>1a</sub> is as defined in formula (II), suprofen residue, R<sub>3a</sub> is H, R<sub>2a</sub> is methyl and T<sub>1</sub> = -CO-;
- when R<sub>1a</sub> is as defined in formula (VI), R is the residue of indoprofen when T<sub>1</sub> = -CO-, R<sub>2a</sub> = H and R<sub>3a</sub> = CH<sub>3</sub>; of indobufen when R<sub>2a</sub> is equal to H and R<sub>3a</sub> = C<sub>2</sub>H<sub>5</sub>; T<sub>1</sub> = -CO-;
- when R<sub>1a</sub> is as defined in formula (VIII), R is the etodolac residue when R<sub>2a</sub> = R<sub>3a</sub> = H and T<sub>1</sub> = -CO-;
- when R<sub>1a</sub> is as defined in formula (VII), R is the fenoprofen residue when R<sub>3a</sub> = H, R<sub>2a</sub> = CH<sub>3</sub> and T<sub>1</sub> = -CO-;
- when R<sub>1a</sub> is as defined in formula (III), R is the fenbufen residue when R<sub>2a</sub> = R<sub>3a</sub> = H and T<sub>1</sub> = -CO-;
- when R<sub>1a</sub> is as defined in formula (IX), R is the flurbiprofen residue when R<sub>3a</sub> = H, R<sub>2a</sub> = CH<sub>3</sub>, T<sub>1</sub> = -CO-;
- when R<sub>1a</sub> is as defined in formula (X) R is the tolmetin residue when R<sub>2a</sub> = R<sub>3a</sub> = H, T<sub>1</sub> = -CO-.

In group IIID) R<sub>1a</sub> corresponds to the following formulas:

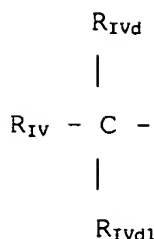
- IIIa), when R<sub>2a</sub> = H and R<sub>3a</sub> = CH<sub>3</sub> the pranoprofen residue is obtained: α-methyl-5H-[1]benzopyran-[2,3-b]pyridin-7-acetic acid; in the preferred compound R<sub>2a</sub> = H, R<sub>3a</sub> = CH<sub>3</sub>, T<sub>1</sub> = -CO- and in the precursor the free valence is saturated with OH;
- (XXX), when R<sub>2a</sub> = H and R<sub>3a</sub> = CH<sub>3</sub> the bermoprofen residue is obtained: dibenz[b,f]oxepin-2-acetic

acid; in the preferred compound  $R_{2a} = H$ ,  $R_{3a} = CH_3$ ,  $T_1 = -CO-$ ;

- (XXXI), when  $R_{2a} = H$  and  $R_{3a} = CH_3$ , R is the radical of the compound CS-670: 2-[4-(2-oxo-1-cyclohexylidenemethyl) phenyl]propionic acid; the preferred compound has  $R_{2a} = H$ ,  $R_{3a} = CH_3$ ,  $T_1 = -CO-$ ;
- (XXXII), when  $R_{2a} = R_{3a} = H$ , the pemedolac residue is obtained; when  $R_{2a} = R_{3a} = H$   $T_1 = -CO-$ ;
- (XXXIII), when  $R_{2a} = R_{3a} = H$ , the pirazolac residue is obtained: 4-(4-chlorophenyl)-1-(4-fluorophenyl)-3-pyrazol acid derivatives;  
the preferred compounds have  $R_{2a} = R_{3a} = H$ ,  $T_1 = -CO-$ ;
- (XXXVI), when  $R_{2a} = H$ ,  $R_{3a} = CH_3$  the zaltoprofen residue is obtained; when the residue is saturated with an hydroxyl or aminic group, or with the carboxylic function the compounds are known as dibenzotiepin derivatives; in the preferred compounds  $R_{2a} = H$ ,  $R_{3a} = CH_3$ ,  $T_1 = -CO-$ ;
- (XXXVII), when  $R_{2a} = R_{3a} = H$  the mofezolac residue is obtained: 3,4-di(p-methoxyphenyl)isoxazol-5-acetic acid when the residue is  $CH_2-COOH$ ; in the preferred compounds  $R_{2a} = R_{3a} = H$ ,  $T_1 = -CO-$ ;
- (XII), when  $R_{2a} = R_{3a} = H$  the bromfenac residue is obtained: 2-amino-3-(4-bromobenzoyl)benzeneacetic acid; the preferred compounds have  $T_1 = -CO-$ ,  $R_{2a} = R_{3a} = H$ ;
- (XXXX) when  $R_{2a} = R_{3a} = H$  the sulindac residue is obtained: (Z)-5-fluoro-2-methyl-1-[(4-(methylsulphenyl) -phenyl)methylene]-1H-inden-3-acetic acid; the preferred compounds have  $T_1 = -CO-$ ,  $R_{2a} = R_{3a} = H$ ;

in Group IV) R is

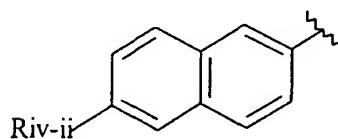




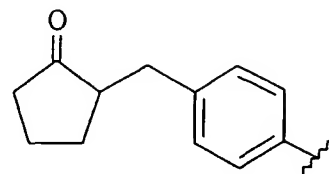
wherein:

$R_{IVd}$  and  $R_{IVd1}$  are at least one H and the other an alkyl from  $C_1$  to  $C_6$  linear or branched, preferably  $C_1$ - $C_2$ , or difluoroalkyl with  $C_1$ - $C_6$  alkyl,  $C_1$  preferred, or  $R_{IVd}$  and  $R_{IVd1}$  form together a methylene group;

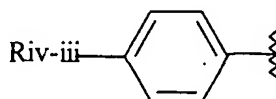
$R_{IV}$  has the following meaning;



(IIB)



(XB)



(IIIB)

wherein the compounds of group IV) have the following meanings:

- in formula (IIB):

$R_{IV-i}$  is  $C_1$ - $C_6$  alkyl,  $C_3$ - $C_7$  cycloalkyl,  $C_1$ - $C_7$  alkoxymethyl,  $C_1$ - $C_3$  trifluoroalkyl, vinyl, ethynyl, halogen,  $C_1$ - $C_6$  alkoxy, difluoroalkoxy with  $C_1$ - $C_7$  alkyl,  $C_1$ - $C_7$  alkoxymethyloxy, alkylthiomethyloxy with  $C_1$ - $C_7$  alkyl, alkyl methylthio with  $C_1$ - $C_7$  alkyl, cyano, difluoromethylthio, phenyl- or phenylalkyl substituted with the  $C_1$ - $C_8$  alkyl; preferably  $R_{IV-i}$  is  $CH_3O-$ ,  $R_{IVd}$  is H and  $R_{IVd1}$  is  $CH_3$ , and is known as naproxene residue;  $T_1 = -CO-$ ;

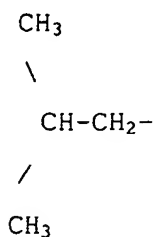
- in formula (XB), of which the loxoprofen residue has

been indicated, the compounds wherein  $R_{IVd}$  is H and  $R_{IVd1}$  is  $CH_3$ ,  $T_1 = -CO-$  are preferred;

- in formula (IIIB):

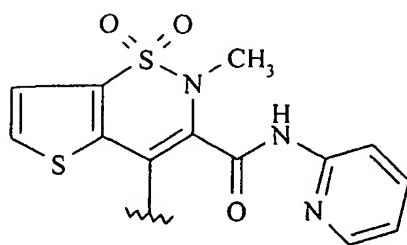
$R_{IV-iii}$  is a  $C_2$ - $C_5$  branched or not branched alkyl,  $C_2$  and  $C_3$  alkyloxy, allyloxy, phenoxy, phenylthio, cycloalkyl from 5 to 7 C atoms, optionally substituted in position 1 by a  $C_1$ - $C_2$  alkyl;

the compound is preferred wherein  $R_{IV-iii}$  is

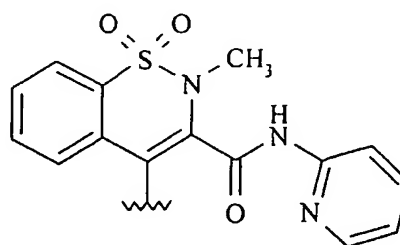


and  $R_{IVd} = H$ ,  $R_{IVd1}$  is  $CH_3$ , compound known as ibuprofen residue,  $T_1 = -CO-$ ;

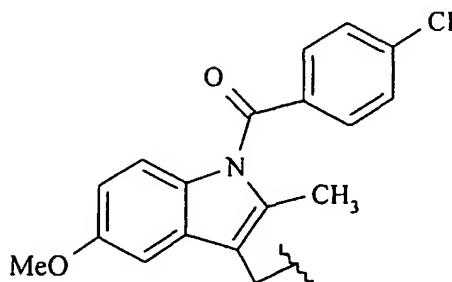
Group V)



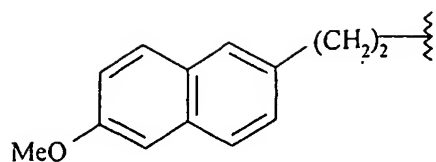
(VIIC)



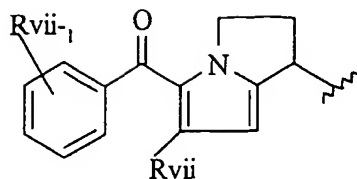
(IXC)



(IVC)

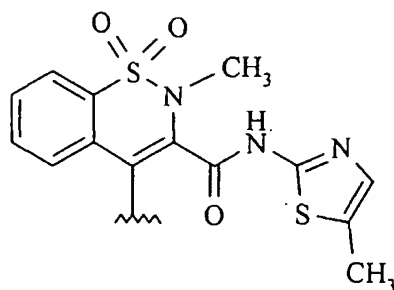


(IIIC)

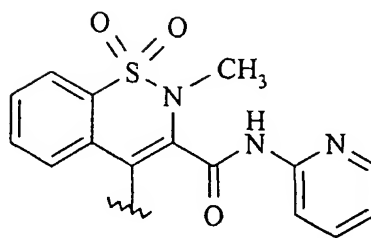


(IIC)

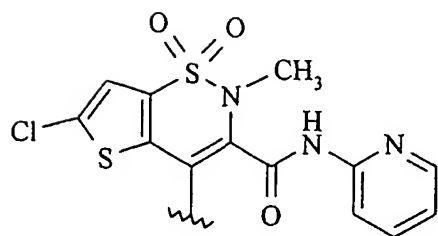
Group VE)



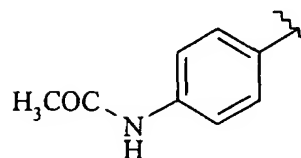
(XC)



(XI)



(XIII)



(XXXXV)

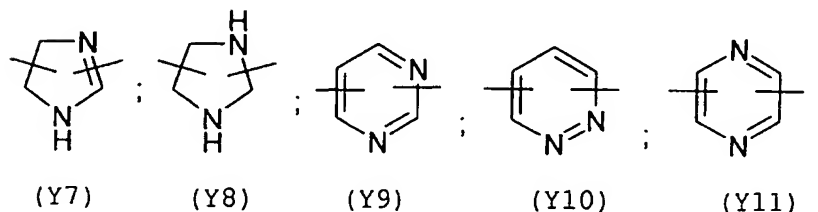
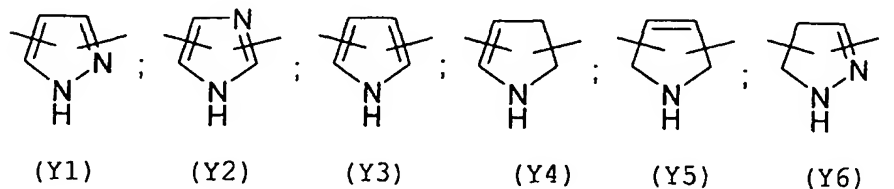
In group V), the compounds have the following meanings:

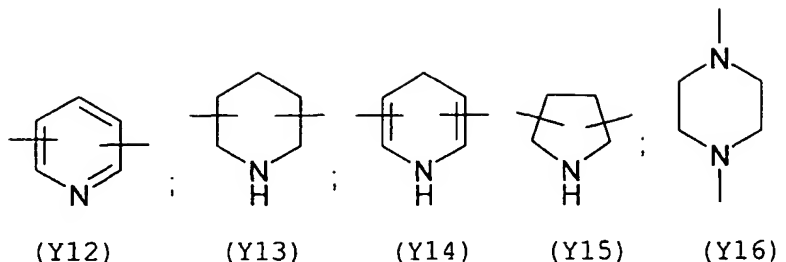
- when R is the formula (IIC),  
 $R_{vii}$  is H or a  $C_1$ - $C_4$  linear or branched alkyl;  
 $R_{vii-1}$  is  $R_{vii}$ , or  $C_1$ - $C_4$  linear or branched alkoxy; Cl, F, Br; the position of  $R_{vii-1}$  being ortho, or meta, or para;  
 the Ketorolac residue is preferred, wherein  $R_{vii}$  and  $R_{vii-1}$  are H, and  $T_1 = -CO-$ ;
- when R is the formula (VIIC),  
 of which the tenoxicam residue has been indicated,

$T_1 = -O-$ ;

- when R is the formula (IXC),  
wherein  $T_1 = -O-$ , the piroxicam residue has been indicated;
- when R is the formula (IIIC),  
wherein  $T_1 = -CO-$ , of which the nabumetone residue has been indicated;
- when R is the formula (IVC),  
wherein  $T_1 = -CO-$ , of which the indomethacin residue has been indicated;
- when R is the formula (XC), the residue X is known as meloxicam; the preferred compounds are those in which  $T_1 = -CO-$ ;
- when R is the formula (XI) the residue is known as ampiroxicam when the termination is  $-CH(CH_3)OCOC_2H_5$ ; the preferred compounds have  $T_1 = -CO-$ ;
- when R is the formula (XIII) and the valence is saturated with H, the residue derives from lornoxicam; the preferred compounds have  $T_1 = -O-$ ;
- when R is the formula (XXXV),  $T_1 = -O-$  and the valence is saturated with H, the compound known as paracetamol is obtained.

5. Use according to claims 1-4, wherein in the compounds of formula (I)  $Y^3$  of formula (III<sup>p</sup>) of C is selected from the following bivalent radicals:





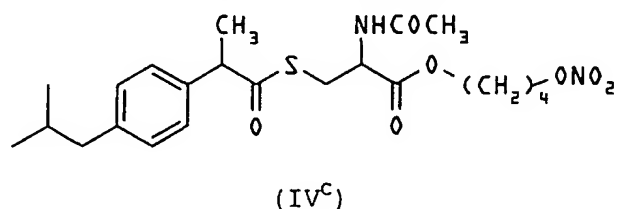
6. Use according to claim 5, wherein  $Y^3$  is selected from the following: (Y12) with the two free valences in the ortho positions with respect to the nitrogen atom; (Y16) with the two valences linked to the two heteroatoms, Y1 (pyrazol) 3,5-disubstituted; Y16 is particularly preferred.
7. Use according to claims 1-6, wherein the following compounds are used:

2-acetyloxybenzoic acid 3-nitrooxymethyl phenyl ester ( $I^c$ );

2-fluoro- $\alpha$ -methyl[1,1'-biphenyl]-4-acetic acid 4-nitrooxy butylester ( $II^c$ );

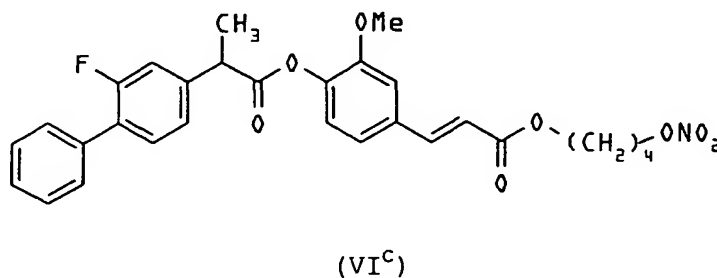
2-[(2,6-dichlorophenyl)amino]benzenacetic acid 4-nitrooxy butyl ester ( $III^c$ );

(S)-N-acetyl-[ $\alpha$ -methyl-4-(2-methylpropyl)benzen-acetyl] cysteine 4-nitrooxybutylester having formula:

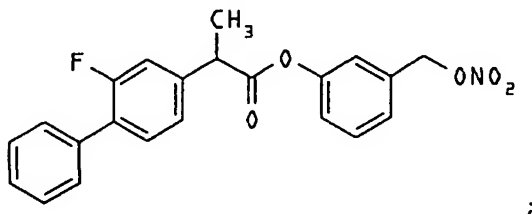


4-nitrooxybutanoic acid 4-acetylaminophenylester ( $V^c$ );

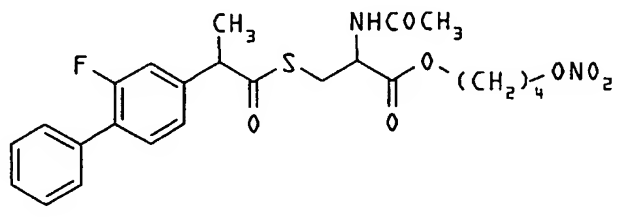
trans-3-[4-[2-fluoro- $\alpha$ -methyl(1,1'-biphenyl)-4-acetyloxy]-3-methoxyphenyl]-2-propenoic acid 4-(nitrooxy) butyl ester, having formula:



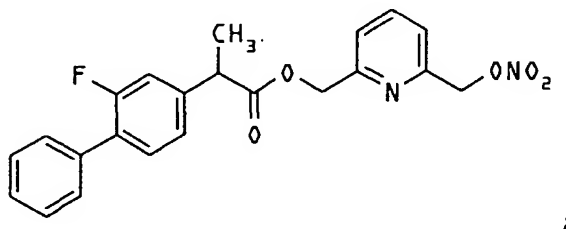
2-Fluoro- $\alpha$ -methyl[1,1'-biphenyl]-4-acetic acid 3-(nitrooxymethyl)phenyl ester having formula:

(VII<sup>c</sup>)

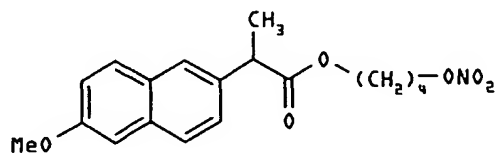
(S)-N-acetyl-[2-fluoro- $\alpha$ -methyl(1,1'-biphenyl)-4-acetyl] cysteine 4-(nitrooxy)butyl ester having formula:

(VIII<sup>c</sup>)

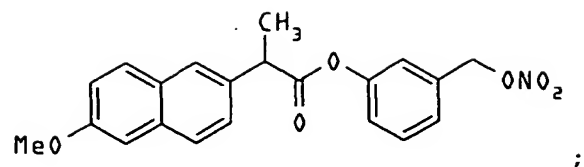
2-Fluoro- $\alpha$ -methyl[1,1'-biphenyl]-4-acetic acid 6-(nitrooxy methyl)-2-methylpyridyl ester having formula

(XI<sup>c</sup>)

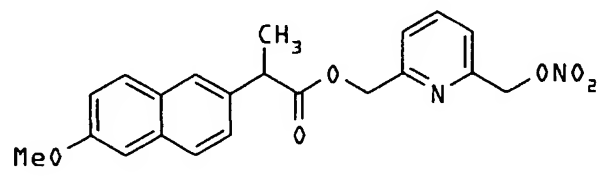
(S)-6-methoxy- $\alpha$ -methyl-2-naphthalenacetic acid 4-(nitrooxy)butyl ester having formula :

(X<sup>c</sup>) ;

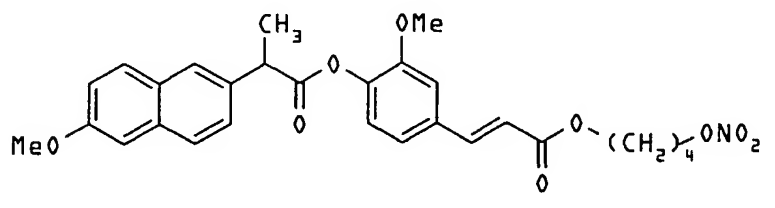
(S)-6-methoxy- $\alpha$ -methyl-2-naphthalenacetic acid 3-(nitrooxymethyl)phenyl ester having formula:

(XI<sup>B</sup>)

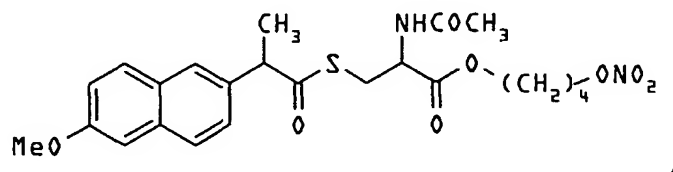
(S)-6-methoxy- $\alpha$ -methyl-2-naphthalenacetic acid 6-(nitrooxymethyl)-2-methylpyridyl ester having formula:

(XII<sup>C</sup>)

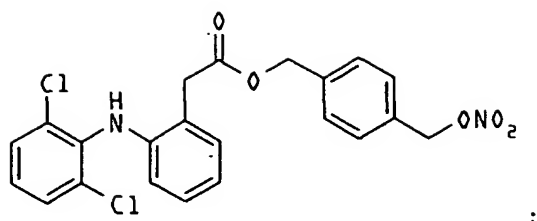
trans-3-[4-[6-methoxy- $\alpha$ -methyl-2-naphthalenacetyloxy]-3-methoxyphenyl]-2-propenoic acid 4-(nitrooxy)butyl ester having formula:

(XIII<sup>C</sup>)

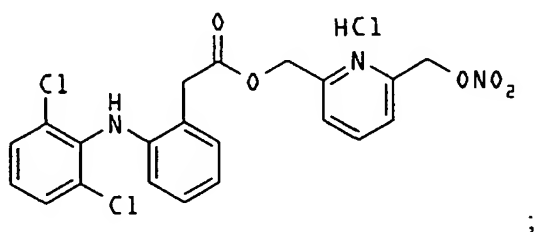
(S,S)-N-acetyl-S-(6-methoxy- $\alpha$ -methyl-2-naphthaleneacetyl) cysteine 4-(nitrooxy)butyl ester having formula:

(XIV<sup>C</sup>)

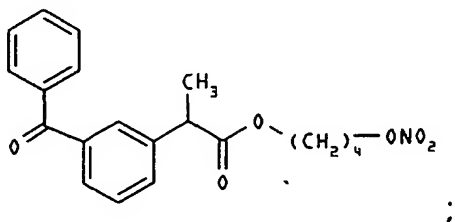
2-[(2,6-dichlorophenyl)amino]benzenacetic acid 4-(nitrooxy methyl)phenylmethyl ester having formula:

(XV<sup>c</sup>)

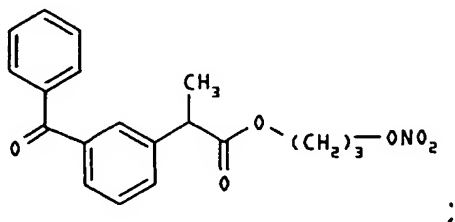
2-[(2,6-dichlorophenyl)amino]benzenecetic acid 6-(nitrooxymethyl)-2-methylpyridyl hydrochloride ester having formula:

(XVI<sup>c</sup>)

(S)-3-benzoyl-alpha-methyl-benzenecetic acid 4-(nitrooxybutyl) ester having formula:

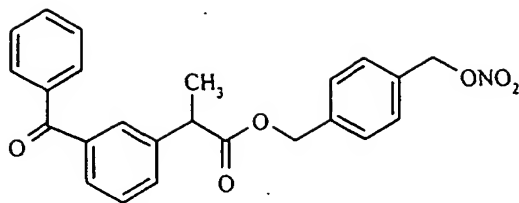
(XVII<sup>c</sup>)

(S)-3-benzoyl-alpha-methyl-benzenecetic acid 3-(nitrooxypropyl) ester having formula:

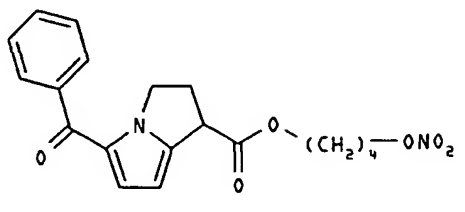
(XVIII<sup>c</sup>)

(S)-3-benzoyl-alpha-methyl-benzenecetic acid 4-(nitrooxymethyl) phenylmethyl ester having formula:

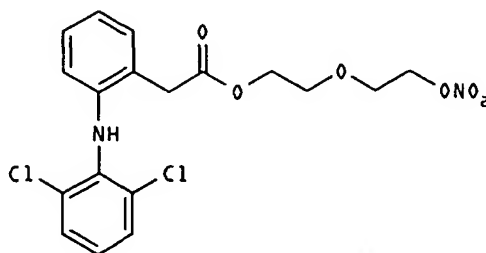


(XIX<sup>c</sup>)

5-benzoyl-2,3-dihydro-1H-pyrrolizine-1-carboxylic acid 4-(nitrooxy)butyl ester having formula:

(XXI<sup>c</sup>)

2-[(2,6-dichlorophenyl)amino]benzenacetic acid 5 (nitrooxy)ethoxyethyl ester having formula:

(XX<sup>c</sup>)

1-(4-Chlorobenzoyl)-5-methoxy-2-methyl-1H-indole-3-acetic acid 3-(nitrooxymethyl)phenyl ester (XXI<sup>c</sup>)

8. Use according to claims 1-7, wherein the compounds of formula (I) are administered in pharmaceutical formulations by oral, parenteral and topical administration.
9. Use according to claims 1-8 for the prevention of arthritis relapses

## INTERNATIONAL SEARCH REPORT

Internal application No  
PCT/EP 03/03183

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A61K31/616 A61K31/19 A61K31/195 A61K31/165 A61K31/216  
A61K31/44 A61K31/40 A61P19/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

BIOSIS, EPO-Internal, MEDLINE, CHEM ABS Data, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>DEL SOLDATO PIERO ET AL: "NO-aspirins: A class of new anti-inflammatory and antithrombotic agents." TRENDS IN PHARMACOLOGICAL SCIENCES, vol. 20, no. 8, August 1999 (1999-08), pages 319-323, XP002250036 ISSN: 0165-6147 the whole document</p> <p style="text-align: center;">--- -/--</p>	1-9



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

## \* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

4 August 2003

Date of mailing of the international search report

18/08/2003

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## INTERNATIONAL SEARCH REPORT

Internal Application No  
PCT/EP 03/03183

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CUZZOLIN L ET AL: "ANTI-INFLAMMATORY POTENCY AND GASTROINTESTINAL TOXICITY OF A NEW COMPOUND, NITRONAPROXEN" PHARMACOLOGICAL RESEARCH, ACADEMIC PRESS, LONDON, GB, vol. 31, no. 1, 1995, pages 61-65, XP009001122 ISSN: 1043-6618 abstract; figure 1 p.62, left column "adjuvant arthritis" and right column "arthritis" ---	1-9
X	SOLDATO DEL P ET AL: "NITRIC OXIDE-RELEASING NSAIDS, A NOVEL CLASS OF SAFE AND EFFECTIVE ANTI-INFLAMMATORY AGENTS" INFLAMMOPHARMACOLOGY, KLUWER ACADEMIC PUBLISHERS, DORDRECHT, NL, vol. 4, no. 2, 1996, pages 181-188, XP009001125 ISSN: 0925-4692 the whole document ---	1-9
X	DE 44 20 523 A (CASSELLA AG) 14 December 1995 (1995-12-14) the whole document ---	1-9
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X	KATO S ET AL: "Low gastric toxicity of nitric oxide-releasing aspirin, NCX-4016, in rats with cirrhosis and arthritis." DIGESTIVE DISEASES AND SCIENCES. UNITED STATES AUG 2001, vol. 46, no. 8, August 2001 (2001-08), pages 1690-1699, XP009014766 ISSN: 0163-2116 abstract "induction of cirrhosis" page 1691, left-hand column ---	1-9
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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>HOF VAN 'T R J ET AL: "NO-NSAIDS: A NOVEL CLASS OF OSTEOCLAST INHIBITORS"            CALCIFIED TISSUE INTERNATIONAL, NEW YORK, NY, US,            vol. 64, no. SUPPL 1,            7 May 1999 (1999-05-07), page S59            XP009004823            ISSN: 0171-967X            abstract</p> <p>---</p>	1-9
Y	<p>BURGAUD ET AL: "HCT-1026 TREATMENT OF SEPTIC SHOCK TREATMENT OF URINARY INCONTINENCE TREATMENT OF OSTEOPOROSIS NITRIC OXIDE DONOR"            DRUGS OF THE FUTURE, BARCELONA, ES,            vol. 24, no. 8, 1999, pages 858-861,            XP009004849            ISSN: 0377-8282            the whole document</p> <p>---</p>	1-9
Y	<p>BURGAUD J L ET AL: "NITRIC-OXIDE RELEASING MOLECULES: A NEW CLASS OF DRUGS WITH SEVERAL MAJOR INDICATIONS"            CURRENT PHARMACEUTICAL DESIGN, BENTHAM SCIENCE PUBLISHERS, SCHIPHOL, NL,            vol. 8, no. 3, 2002, pages 201-213,            XP001122072            ISSN: 1381-6128            abstract            page 202, left-hand column, paragraph 3</p> <p>---</p>	1-9
Y	<p>ARMOUR K J ET AL: "INHIBITION OF BONE RESORPTION IN VITRO AND PREVENTION OF OVARECTOMY-INDUCED BONE LOSS IN VIVO BY FLURBIPROFEN NITROXYBUTYLESTER (HCT1026)"            ARTHRITIS AND RHEUMATISM, LIPPINCOTT, PHILADELPHIA, US,            vol. 44, no. 9, September 2001 (2001-09),            pages 2185-2192, XP009004824            ISSN: 0004-3591            abstract</p> <p>---</p>	1-9
Y	<p>PAUL-CLARK M J ET AL: "POTENT ANTIARTHRITIC PROPERTIES OF A GLUCOCORTICOID DERIVATIVE, NCX-1015, IN AN EXPERIMENTAL MODEL OF ARTHRITIS"            PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF USA, NATIONAL ACADEMY OF SCIENCE. WASHINGTON, US,            vol. 99, no. 3,            5 February 2002 (2002-02-05), pages            1677-1682, XP001097628            ISSN: 0027-8424            abstract</p> <p>-----</p>	1-9

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/EP 03/03183

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 1-6,8,9 (all in parts)  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 1-6,8,9 (all in parts)

Present claims 1-6, 8 and 9 relate to an extremely large number of possible compounds and uses. Support within the meaning of Article 6 PCT and/or disclosure within the meaning of Article 5 PCT is to be found, however, for only a very small proportion of the compounds and uses claimed. In the present case, the claims so lack support, and the application so lacks disclosure, that a meaningful search over the whole of the claimed scope is impossible. Consequently, the search has been carried out for those parts of the claims which appear to be supported and disclosed, namely those parts relating to the uses of compounds of claim 7 as well as the examples.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

## INTERNATIONAL SEARCH REPORT

 Internatl Application No  
 PCT/EP 03/03183

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